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ABSTRACT

Geographers from Asian nations, the United Kingdom, and the United States wrote this population geography curriculum guide to help universities in developing nations of Asia increase the amount of population-oriented materials in their undergraduate curricula. The developers do not advise that the guide be used in its entirety for a single course. The material in the guide easily can be incorporated into existing courses in human geography at all university levels and in cartography and quantitative offerings. The developers note in the introduction that although several excellent textbooks are available in the field, they have not stressed many of the themes that are prominent in this guide. For example, a section on family planning programs attempts to identify the geographer's role in population studies, a role that has been neglected in the past. Another section on remote sensing and cartography provides a modern view of the role that geographic tools can play in future developments. The guide contains background readings and references on a variety of topics. A case study approach is sometimes used. The topics presented are: analysis of the spatial concentration of population; demography of early populations and the Boserup thesis; human and social resource analysis in population geography; migration and mobility; urban population problems; labor force mobility in Asian countries; the contribution of geography to family planning research; and graphical displays and remote sensing. (Author/RM)

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A CURRICULUM GUIDE FOR POPULATION GEOGRAPHY

Prepared by participants in the Geography Workshops
of the Fourth and Fifth Summer Seminars in Population

Edited by Gary Fuller

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Preface

In 1972 a conference of Asian universities held in Yogyakarta, Indonesia, recommended that universities in developing Asia increase the amount of population-oriented materials in their undergraduate curricula. The East-West Population Institute heeded this recommendation by devoting its Fourth (1973) and Fifth (1974) Summer Seminars to disciplinary workshops aimed at development of material to aid in the teaching of population.

The geography workshop of the Fourth Summer Seminar brought together 11 geographers from eight Asian nations and the United States. Participants in this workshop decided to produce a *Curriculum Guide* and developed ideas about its purpose and content. They recognized that the scope and domain of population geography differ from country to country and that the roles of geography departments vary from university to university. The *Curriculum Guide* would therefore have to cover a broad range of concerns and interests. Although the participants recognized the desirability of identifying a consensus about the goals of population geography, they also recognized that the process of identification would be lengthy, the need for curricular materials urgent, and the time available extremely limited.

During the spring of 1974, participants in a seminar in population geography at the University of Hawaii completed the planning stage and began development of specific sections of the *Guide*. Most of the members of the seminar participated in one or both of the Summer Seminar workshops.

The second workshop, held in 1974, contained 20 geographers from seven Asian nations, the United Kingdom, and the United States. This group edited previously produced materials and completed work on the first draft of the *Guide*. In all, they produced over 800 manuscript pages and 70 charts, maps, and diagrams. Publication costs dictated that some of the materials be deleted from this volume. The decision to include or eliminate a section was based primarily on two criteria: (1) the material was sufficiently original to warrant separate publication, and (2) the material contributed to an understanding of population geography within the Asian/Pacific region.

There are several major contributions represented by this work. Primarily, it was conceived and developed in an intercultural setting. Although it is undoubtedly true that the majority of assumptions underlying this work are part and parcel of Western scholarship, it is equally true that a significant portion of the contributions reflects the value systems and aspirations of developing nations.

Furthermore, the *Guide* is a pioneering attempt to bring together a variety of approaches used by population geographers. Although several excellent textbooks are available in the field, they have not stressed many of the themes that are prominent in the *Guide*. For example, the section on family planning programs attempts to identify the geographer's role in this important aspect of population studies, a role that has been neglected in the past. The section on remote sensing and cartography provides a modern view of the role that these important geographic tools can play in future developments.

Although I believe the *Guide* has a good deal to offer to both the student and the instructor, it was developed under severe constraints which are inevitably reflected in the printed page. All the substantive work done on the *Guide* was performed in only 30 working days. As an active observer of this frantic process, I am amazed that so much work could have been done in so short a time. We might have been able to lend more polish to the *Guide* under more leisurely conditions, but then we would have lost the personal, intercultural contact that provides its flavor. Similarly, we lack proper expertise in some areas. For example, our original plans called for at least one section on population pressure and the deterioration of the environment, but we were unable to obtain contributors to this important issue.

The *Guide* is intended to aid, not dictate to, the instructor, providing not a set of lecture notes, but rather aids in their development. It would not be advisable to use the *Guide* in its entirety for a single course. Instead, instructors can find material here that might be incorporated in existing courses in human geography at all university levels, and in cartography and quantitative offerings. Some of the sections, particularly those that take case study approaches, might be used for course readings.

We would like to hear from users of the *Guide* concerning their experiences with it. Although a detailed survey of selected users is contemplated, comments would be most welcome and may be sent to me at the East-West Population Institute.

Gary Fuller
*Geography Workshop Coordinator
and Editor*

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Reference and Data Sources

There is no escaping the thesis that the pursuit of any significant question in population geography inevitably familiarizes the student with every aspect of geography and its neighboring fields.

Wilbur Zelinsky, *Prologue to Population Geography*, 1966, p. 53.

It is unconventional to begin a volume with a bibliography, yet in developing a course or a research project a bibliographic guide to the topic is the first priority. In population geography, as in all areas of demographic inquiry, the kind and quality of available data are of paramount importance. Indeed, the science of demography owes its existence to the paucity of information about human populations. No course that purports to deal with population is complete without exposing students to the notion of how unsure we are about the numbers, movement, and rate of increase of the world's people.

The East-West Population Institute (EWPI) is fortunate to have what may be the best special-purpose library for research in population geography. Most of the works listed in this section can be found in the EWPI Resource Materials Collection.

BIBLIOGRAPHIC AND AUDIOVISUAL SOURCES

The purpose of this bibliography is to introduce teachers and students in the field of population geography to some of the resources that will help them in their teaching and research. Since the field is still relatively young, its content is fluid and broadly interpreted. Therefore, this bibliography is only a beginning. Its contents are selective and are not intended to encompass every topic and region covered by population geography.

There are gaps in the material that the user should be aware of, and eventually correct. These gaps are the result of a reliance on materials that are primarily in English and are written by, and for, Western geographers. Sources in other languages are needed to make this bibliography complete.

BIBLIOGRAPHIES AND INDEXES

American Geographical Society. *Current Geographical Publications*. 10 issues a year. New York, 1938—

Lists all new books, periodicals, maps, and pamphlets received at the American Geographical Society. Population material found under "Geography of Population" and by country.

- Berry, Brian, and Allen Pred. *Central Place Studies: A Bibliography of Theory and Application*. Philadelphia: Regional Science Research Institute, 1965. (U.S. \$4.00)
Lists the central place research done before 1964; also contains a summary of the development of the theory as initiated by Walter Christaller and expanded upon or refined by others.
- Breese, Gerald. *Urban Southeast Asia: A Selected Bibliography of Accessible Research, Reports and Related Materials on Urbanism and Urbanization in Hong Kong, Indonesia, Malaysia, The Philippines, Singapore, Thailand, Vietnam*. New York: Southeast Asia Development Advisory Group, 1973.
Collection of articles on urbanization in Southeast Asia; arranged by author under each country and covering the period through 1970.
- Eldridge, Hope T. *The Materials of Demography: a Selected Bibliography*. New York: Columbia University Press, 1969. (out of print)
Annotated guide to population literature published until 1958. Has sections on statistical sources that might be useful, although it is somewhat outdated.
- Geographical Abstracts*. East Anglia: University of East Anglia, 1967—. Part D, Social Geography.
Articles on settlement and population geography are annotated here.
- Goode, Stephen H. *Population and the Population Explosion: a Bibliography for 1970—*
Troy, N.Y.: The Whitson Publishing Co., 1973— (U.S. \$17.00)
An exhaustive annual bibliography of articles on population from journals and books published during 1970; annual supplements are being published regularly. Articles are international in scope. Bibliography is divided into alphabetical listings by title and by some 100 major subjects.
- Kohn, Clyde F. *The Geography of Rural Settlements and Population*. Washington, D.C.: Division of Geology and Geography, National Research Council, 1952. (out of print)
Papers on settlement and population with an extensive bibliography. Dated but useful.
- Mangalam, J.J. *Human Migration: a Guide to Migration Literature in English, 1955—1962*. Lexington: University of Kentucky Press, 1968. (U.S. \$15.00)
Bibliography of articles on all aspects of migration, arranged by author with an index by subject. Contains a concise but definitive chapter on migration theory.
- Olsson, Gunnar. *Distance and Human Interaction: A Review and Bibliography*. Philadelphia: Regional Science Research Institute, 1965. (U.S. \$3.50)
Provides a description of location theory, diffusion models, and migration models, and includes a bibliography of selected articles.
- Population Association of America, Inc. *Population Index*. Princeton, N.J.: Office of Population Research, 1935— quarterly. (U.S. \$15.00)
This is the basic reference work for demographic research. It provides a current and comprehensive list of all books, articles, seminars, monographs, government documents, and papers on all aspects of demography. It is arranged by broad subject classification with author and geographical indexes. Original articles and statistical summaries are also included. The volumes from 1935 to 1968 have also been published in separate, cumulated author and geographical indexes to facilitate location of materials.
- Population Reference Bureau, Inc. *A Sourcebook on Population: 1970—1976*. Compiled and edited by Tina Bussink et al. Washington, D.C.: Population Reference Bureau, 1976. (U.S. \$3.95)

An indispensable reference tool for anyone interested in population research. This 72-page update of the *Sourcebook*, first published in 1969, covers major publications for the years 1970–1976 in the broad field of population studies. Coverage includes U.S., foreign, and international books and journals. Subjects include demographic analysis; fertility; marriage; women's nonfamilial roles; mortality and morbidity; migration and population distribution; causes and consequences of demographic behavior; and population policies and laws. Publishers' addresses and prices are included wherever possible.

Shaw, R. Paul. *Migration Theory and Fact: A Review and Bibliography of Current Literature*. Philadelphia: Regional Science Research Institute, 1975.

Contains an excellent chapter on contemporary migration theory and an extensive bibliography.

Strand, Sverre. *Urban Geography, 1950–'70: A Comprehensive Bibliography of Urbanism as Reflected in the Articles and Book Reviews of 72 American, Canadian, Dutch and Scandinavian Geographical Periodicals*. Monticello, Illinois: Council of Planning Libraries, 1973. (U.S. \$13.00)

Texas University. Population Research Center. *International Population Census Bibliography*. Austin: Department of Sociology, University of Texas, 1967. 7 vols.

Bibliographical citations through 1967 for the censuses of every region of the world, by country and date. Invaluable source for those doing statistical work in population. A new edition will be published in 1978–1979.

United Nations Educational, Scientific and Cultural Organization. Regional Office for Education in Asia. *Population. Population and Family Education and Family Planning: A Bibliography*. Bangkok: Population Education Clearing House Service, 1973) (free)

A listing of books, periodical articles, and pamphlets on population education available in the library of the UNESCO Regional Office in Bangkok. The index is divided into general, Asian, and national titles, arranged alphabetically by author. Supplements take the listings through July–December 1975.

Urbanization in Developing Countries: an International Bibliography. Compiled by Stanley D. Brunn. East Lansing: Michigan State University, Latin American Studies Center, and Center for Urban Affairs, 1971. (U.S. \$10.00)

An international, interdisciplinary, and multilingual bibliography with 7,000 entries on urbanization in three major world regions—Latin America, Africa, and Asia.

Winton, Harry. *Man and the Environment: A Bibliography of Selected Publications of the United Nations System 1946–1971*. New York, London: Unipub, 1972. (U.S. \$14.30)

Any publications relating to population, natural resources, and ecology may be found in this list of United Nations publications.

Zelinsky, Wilbur. *A Bibliographic Guide to Population Geography*. Chicago: Department of Geography, University of Chicago, 1962; reprinted Westport, Conn.: Greenwood Press, 1976. (U.S. \$15.75)

Although 12 years old, this remains the best guide to publications in the field of population geography. It lists items on the different components of population, as well as for different areas of the world. The introduction is a summary of the method and content of population geography.

BOOKS

- Albaum, Melvin. *Geography and Contemporary Issues*. New York: J. Wiley, 1973. (U.S. \$7.95)
This reader helps pinpoint the real-life concerns of geographers. Section Five is especially relevant to population geography.
- Broek, J.M.H. *A Geography of Mankind*. New York: McGraw-Hill, 1973. 3d ed. (U.S. \$12.95)
The final section of the text has four chapters on population entitled "Differential Growth of Populations," "Population Movements," "Problems of Population Growth," and "What Man has Wrought."
- Clarke, John I. *Population Geography*. New York: Pergamon Press, 1972. 2d ed. (U.S. \$5.25)
Defines the field of population geography and then discusses each component of population in turn. Most useful for its demographic definitions and measures of distribution and density. Considers environmental conditions as major determinants of population distribution.
- _____. *Population Geography and the Developing Countries*. New York, Oxford: Pergamon Press, 1971. (U.S. \$6.75)
Discusses population dynamics in the countries of Asia, Africa, and Latin America.
- Chorley, Richard, ed. *Directions in Geography*. London: Methuen, 1973. (U.S. \$6.00)
Theory and methodology of the "new" geography are summarized. Important for any geography student.
- Demko, George J., Harold M. Rose, and George A. Schnell, eds. *Population Geography: a Reader*. New York: McGraw-Hill, 1970. (U.S. \$8.55)
A collection of the more important articles in population geography, from Trewartha's "Case for Population Geography" to Lee's "Theory of Migration." Useful for outside readings, but dated.
- Ehrlich, Paul. *Human Ecology: Problems and Solutions*. San Francisco: Jossey-Bass, 1973. (U.S. \$4.75, paper)
A shorter and less detailed version of the earlier *Population, Resources and Environment* (1970) prepared for college students. Focus is on population control as one means of solving the "biological and physical aspects of man's present problems. . ."
- Eyre, S.R., and G.R.J. Jones, eds. *Geography as Human Ecology: Methodology by Example*. New York: St. Martin's Press, 1966. (U.S. \$9.75)
Eleven case studies of different regions written in an ecological framework. Considers the dynamic factors in an ecosystem, including man. Includes introductory essay on human ecology as the central integrating theme in geography.
- George, Pierre. *Introduction à l'Etude Géographique de la Population du Monde*. Paris: Presses Universitaires de France, 1951.
- _____. *Questions de Géographie de la Population*. Paris: Presses Universitaires de France, 1959.
Two books by the noted French geographer on the theory and content of population geography.
- Hawley, A.H. *Human Ecology*. New York: Ronald Press, 1950. (U.S. \$7.50)
This introduction to the study of population in an ecological framework has not been surpassed. Part 2 describes the dynamics of population and Part 3, the fundamentals of spatial distribution. Hawley's *Urban Society: an Ecological Approach* (New York: Ronald Press, 1971, U.S. \$7.50) is a good expansion of his work on urbanization.

- International Geographical Union. Commission on Population Geography. *Population Geography*, 1973. Compiled by J.C. Hansen and L. Kosinski. Bergen, Norway, 1973. A comprehensive state-of-the-art summary of population geography prepared for the International Geographical Union. Based partly on a questionnaire sent to geography departments in different countries, and partly on past research, it brings the discipline up to 1973. Includes a bibliography. A separate publication on *Population Mapping* will be cited in another paper.
- McGaugh, Maurice. *A Geography of Population and Settlement*. Dubuque, Iowa: W.C. Brown, 1970. (U.S. \$2.00)
A short but interesting textbook on population and settlement geography. Useful for students. Includes bibliography.
- Mikesell, M., ed. *Geographers Abroad: Essays on the Problems and Prospects of Research in Foreign Areas*. Chicago: University of Chicago, Dept. of Geography, 1973. (U.S. \$5.00)
As the subtitle implies, this collection of papers presented at a conference sponsored by the Harris Foundation in 1972 explores the status of geography and geographic research in different areas. While it is not directed at population geographers in particular, there is much valuable information here, and good bibliographical references.
- Pitié, Jean. *Géographie de la population mondiale*. Paris: Sirey, 1973. (U.S. \$20.00)
Useful text on world population geography for French-speaking countries. Includes a supplemental packet with practical exercises and maps.
- Spencer, J.E. *Introducing Cultural Geography*. New York: John Wiley, 1973. (U.S. \$12.95)
The latest edition of this textbook includes an excellent chapter entitled "The Spiral of Population on a Humanized Earth: the Troublesome Uniqueness of Our Time."
- Trewartha, Glenn T. *A Geography of Populations*. New York: John Wiley, 1969. (U.S. \$3.95)
One of the first geographers to recognize the central place of population study within the discipline, Trewartha uses the topical approach in this volume on world population.
- _____. *The Less-Developed Realm: a Geography of Its Population*. New York: John Wiley, 1972. (U.S. \$7.95)
This follows his earlier work on world population, concentrating on the population problems of the countries of Asia, Africa, and Latin America.
- _____. *The More-Developed Realm*. Elmsford, N.Y.: Pergamon Press, 1977. (U.S. \$14.00)
The final book of the series deals with population problems faced by Europe, North America, and Japan.
- Wilson, M.G.A. *Population Geography*. Melbourne: T. Nelson, 1968. (U.S. \$2.40)
- Zelinsky, Wilbur. *A Prologue to Population Geography*. Englewood Cliffs, N.J.: Prentice-Hall, 1966. (U.S. \$1.95)
This excellent introduction to population geography explores the meaning of, nature of, and uses of the field. Zelinsky constructs a framework for the new area of study, identifying the major elements of population. He then takes one element—the numbers and distribution of people—and shows how it is studied by the geographer. In the last section, he discusses population on a regional basis.
- Zelinsky, Wilbur, ed. *Geography and a Crowding World*. New York: Oxford University Press, 1970. (U.S. \$5.95)

Papers from a Symposium on Population Pressures upon Physical and Social Resources in Developing Lands, held at Pennsylvania State University in 1969. The role of the geographer in the population pressure-resource crunch is stressed.

ARTICLES

- Ackerman, E.A. "Geography and Demography." In P.M. Hauser and O.D. Duncan, eds., *The Study of Population*. Chicago: University of Chicago Press, 1959, pp. 717-727.
Population as studied by two disciplines.
- Anderson, R.C. "The Role of Human Geography in the Study of Emerging Nations." *Social Education* 29:331-337, October, 1965.
How the study of population can help students in understanding the growth of the less-developed nations.
- Chapman, Murray. "Population Geography and the Island Pacific." *Pacific Viewpoint* 16(2):177-188. (Available as East-West Population Institute Reprint no. 69.)
- Hooson, D.J.M. "The Distribution of Population as the Essential Geographical Expression." *Canadian Geographer* 17:10-20, 1960.
Why population is an integral part of geographical study.
- James, P.E. "The Geographic Study of Population." In P.E. James and C.F. Jones, eds., *American Geography: Inventory and Prospect*. Syracuse: Syracuse University Press, 1954, pp. 106-122.
An outdated, but still relevant, summary of the scope, objectives, problems, and completed research in the field of population geography in 1954.
- Johnson, J.H. "Recent British Contributions to the Study of Population Geography." *Geographia Polonica* 18:53-73, 1970.
A literature review of work by British geographers on population.
- Jones, R.A. "Population Geography." In R.E. Gable, ed., *A Handbook for Geography Teachers*. Bloomington, Ind.: National Council for Geographic Education, 1966, pp. 155-187.
Good overall analysis of population geography for teachers.
- Trewartha, G.T. "The Case for Population Geography." Association of American Geographers, *Annals* 43:71-97, 1953.
The definitive statement of the place of population studies in geography; it contains a philosophical consideration of their nature, scope, and relationship to the rest of geography and Trewartha's outline for a syllabus in population geography.
- Webb, J.W. "Population Geography." In R.W. Cook and J.H. Johnson, eds., *Trends in Geography: an Introductory Survey*. London, New York: Pergamon Press, 1969, pp. 90-101.
Another review of the field and recent research.
- Wrigley, E.A. "Geography and Population." In R.J. Chorley and P. Haggett, eds., *Frontiers in Geographical Teaching*. London: Methuen, 1967, pp. 62-80.
- . "Demographic Models and Reality." In R.J. Chorley and P. Haggett, eds., *Models in Geography*. London: Methuen, 1967, pp. 189-215.
Summary-review articles on population research in geographical context.

TEACHING MATERIALS

- American Universities Field Staff. *Reports on Population*. Hanover, N.H.: AUFS.
A series of reports on population in different countries, written by area specialists. Designed for classroom use. They provide good background material for discussion.

_____. *Perspectives on Population.*

Ten booklets on population problems in different countries; less technical than the *Reports*; also intended for classroom use.

Anderson, Randall C. "Introducing Concepts from Cultural Geography through Problem Solving," *Journal of Geography*, January 1968.

Problem-solving activities for students, based on material on global and areal population dynamics, and on population patterns and resource development.

_____. "Teaching World Population Dynamics in Global Perspective," *Social Studies*, October 1968.

Suggested activities for teaching population, particularly man-environmental relationships, in secondary schools.

Brown, Jerry L. *A Plan for an Instructional Unit on Population Dynamics: a Final Report.* Bloomington, Indiana: Population Education Project, Indiana University, 1971.

Helpful hints for teachers planning an outline for a population course.

Carey, George W. *Teaching Population Geography: An Interdisciplinary Ecological Approach.* New York: Teachers College, Columbia University, 1969. (U.S. \$7.00)

Provides teachers with ideas for introducing population study to students through the use of case studies that relate population and the carrying capacity of the environment. Takes an ecological approach; illustrates various alternatives for maintaining an equilibrium between man and resources. Contains a useful, annotated bibliography and list of visual media.

Center for War/Peace Studies. *Teaching about Population: A Guide to Discussion, Study and Resources.* New York, 1973. (U.S. \$1.50)

Special issue of *Intercom* prepared with the cooperation of the Population Council to acquaint teachers with methods and resources for teaching facts of population. Contains an actual unit on population to be used, as well as valuable lists of resources that could be acquired at little cost.

Griffin, Paul F. *Geography of Population: a Teacher's Guide.* Palo Alto, Calif.: Fearon Publishers, 1969.

This 1970 Yearbook of the National Council for Geographic Education is devoted entirely to population geography. It contains an extensive section on teaching materials, films, etc.

Hertzberg, Hazel W. *Teaching Population Dynamics: An Instructional Unit for Secondary School Students.* New York: Columbia University, International Studies Program, 1965.

Designed for use by teachers, it presents a basic demographic vocabulary and practice in simple demographic analysis. Good example for teachers wishing to design a similar unit.

Hunter, John, and Melinda A. Meade. "Population Models in High School," *Journal of Geography*, January 1971.

A "how-to" description for constructing three-dimensional models of various countries, based on population density and distribution. The article can be used in high school and college geography courses; includes suggestions for activities and audio-visual aids.

Lee, Everett S., ed. *Population Profiles.* Washington, Conn.: Center for Information on America, 1973. (U.S. \$7.00 for complete series)

A series of 14 pamphlets on various aspects of the population situation in the U.S., which can be incorporated into social studies courses. Teaching guides are available. These are good samples of what might be done for any country.

Long, M., ed. *Handbook for Geography Teachers*. London: Methuen & Co., 1964.

Provides an annotated bibliography of all kinds of geographical resources.

Masscalas, Byron G., and Jack Zevin. "Analyzing Why People Migrate." In Byron G. Masscalas and Jack Zevin, eds., *Man and His Environment*. Chicago: Rand McNally, 1969.

An exercise in which students consider why at various times in history large numbers of people have migrated. Includes a map game enabling students to predict patterns of settlement. Stresses the relationship between population and per capita income.

Sociological Resources for the Social Studies. Boston: Allyn & Bacon, 1972-1973. (U.S. \$6.30 for series & guide)

A series of 10 units on various topics that could be incorporated into social study courses. Among the titles are *Family Size and Society*, *Migration within the United States*, *Population Change: a Case Study of Puerto Rico*, and *Roles of Modern Women*. Each unit includes a fact book and work book for students and an Instructor's Guide.

Teaching Notes on Population, Vol. 1, Spring/Summer, 1972-. Albany: University of the State of New York, State Education Department. Semi-annual. (free)

A journal packed full of ideas and resources for teaching population; it reviews books and films, lists tapes, and provides actual teaching units.

U.S. Bureau of the Census. *Demography Lectures. Courses for Case Studies in Surveys and Census*. Washington, D.C.: Bureau of the Census, 1969. (U.S. \$.50)

This 45-page booklet explains key variables used in population analysis: sources of demographic data, vital statistics, sex and age composition, mortality and fertility, and population estimates and projections. Five lectures with study assignments at the end of each are provided. Written clearly; a useful reference for teaching demography at any level.

Viederman, Stephen, ed. *Population Education*. Special issue of *Social Education*, Vol. 36, No. 4, April 1972. (U.S. \$1.50)

This issue contains special articles on the study and teaching of population for educators, as well as lists of resources—films, books, tapes, and study guides. Published by the National Council of the Social Sciences.

World Law Fund. New York

Games, audiovisual materials and course outlines with a population emphasis. Write for catalog.

GUIDES FOR TEACHERS AND STUDENTS

Allan, George R. *The Graduate Students' Guide to Theses and Dissertations: a Practical Manual for Writing and Research*. San Francisco: Jossey-Bass, 1974. (U.S. \$7.75)

A practical book that tells all the ways to make a thesis or dissertation acceptable, from writing the hypothesis to footnotes and illustrations.

Browning, Clyde A. *Bibliography of Dissertations in Geography, 1901-1969*. Chapel Hill, N.C.: University of North Carolina, Dept. of Geography, 1970.

This compilation of dissertation titles is worth checking before deciding upon a topic for research. Other lists of dissertations and theses can be found in the *Association of American Geographers Annals* and in *The Professional Geographer*.

Durrenberger, Robert W. *Geographical Research and Writing*. New York: Thomas Crowell, 1971. (U.S. \$2.95, paper)

A guide for students doing research in geography; it describes the research process

and tells how to locate sources, from manuscripts to maps. Although it lacks any discussion of how to handle statistical data or do fieldwork, it is still an excellent guide.

Freeman, T.W. *The Writing of Geography*. Manchester: The University Press, 1971. (U.S. \$2.70)

A brief but useful how-to-do-it manual for students writing research papers. Gives useful information on collecting field data.

Haring, L.L., and J.F. Lounsbury. *Introduction to Scientific Geographic Research*. Dubuque, Iowa: W.C. Brown Co., 1971. (U.S. \$2.50)

This guide stresses doing research using the scientific method, even to doing library research by this process. It lists the major geographical references, explains how to set up interviews and fieldwork, and how to handle quantitative analysis.

Martinson, T.L. *Introduction to Library Research in Geography: An Instruction Manual and Short Bibliography*. Metuchen, N.J.: Scarecrow Press, 1972. (U.S. \$4.50)

Handbook for students doing library research: it supplies comprehensive lists of serials, indexes, government publications, and statistical sources. Also provides a stratified flow chart for preparing a bibliography.

Moore, W.G. *A Dictionary of Geography*. Harmondsworth, Middlesex, England: Penguin Books, 1968. (U.S. \$1.45, paper)

Defines and explains terms used in physical geography for the student. Includes maps and illustrations.

Stuart, M.M. *A Bibliography of Masters' Theses in Geography, American and Canadian Universities*. Tualatin, Oregon: Geographical and Area Studies Publications, 1974. (U.S. \$9.90)

A compilation of theses titles by subject; useful for students desiring to see what has already been written on any subject.

United Nations. *Multilingual Demographic Dictionary*. New York: United Nations, 1958. (U.S. \$1.00, paper)

Provides concise but clear definitions of demographic terms that are used by demographers on an international level. Plans call for this to appear eventually in all languages.

Webster's Geographical Dictionary. Springfield, Mass.: Merriam Co., 1969. Rev. ed.

Guide to names of places throughout the world: it also includes historical data and maps. Gives variant spellings of names. Another source with a similar approach is the *Columbia-Lippincott Gazetteer*.

Palmore, James A. *Measuring Fertility and Natural Increase: A Self-Teaching Guide to Elementary Measures*. Honolulu: East-West Population Institute, 1972.

This is a useful guide for new students in population geography; it introduces them to fertility measures, gives definitions, and shows how to compute rates.

_____. *Measuring Mortality: A Self-Teaching Guide to Elementary Measures*. Honolulu: East-West Population Institute, 1973.

This does for mortality what the above reference does for fertility. A useful tool for students.

PERIODICALS

Many articles on population appear in the geographical journals; these can be located by using the indexes *Current Geographical Publications*, *Geographical Abstracts*, and *Population Index*. Comprehensive lists of geographical journals may be found in Chauncy D. Harris, *An Annotated World List of Selected Current Geographical Serials in English*

(Chicago: University of Chicago, Dept. of Geography, 1964). An appendix includes major serials in other languages. In addition to the geographical serials, there are a number of journals in demography or related fields that include articles of interest to population geographers. A selected list of these follows.

Demografi Indonesia. Jakarta: Faculty of Economics, University of Indonesia, 1974—. 2 issues per year.

Demography. Chicago: Population Association of America, 1965—. Quarterly.

Demography-India. New Delhi: Hindustan Book Agency, 1972—. 2 issues per year.

Economic Development and Cultural Change. Chicago: University of Chicago Press, 1952—. Quarterly.

International Migration Review. Staten Island, N.Y.: Center for Migration Studies, 1966—. 6 issues per year.

International Migrations. Geneva: Intergovernmental Committee for European Migration, 1961—.

Migration News. Geneva: International Catholic Migration Commission, 1952—. Bimonthly.

Migration Facts and Figures. Geneva: International Catholic Commission, 1951—. Irregularly.

Population. Paris: L'Institut National d'Etudes Démographiques, 1940—. 6 issues per year.

Population and Development Review. New York: Population Council, 1975—. Quarterly.

Population Bulletin. Washington, D.C.: Population Reference Bureau, Inc., 1945—. 6 issues per year.

Population Review. La Jolla, Calif.: S. Chandrasekhar, 1956—. 1-2 issues per year. (Formerly published in Madras, India.)

Population Studies. London: Population Investigation Committee, 1947—. 3 issues per year.

Social Biology (formerly *Eugenics Quarterly*). Chicago: University of Chicago Press, 1969—. Quarterly.

Theoretical Population Biology. New York: Academic Press. 2 issues per year.

Urban Anthropology. Brockport, N.Y.: SUNY-Brockport, Dept. of Urban Anthropology, 1972—. 2 issues per year.

REPRINTS

Reprints are an inexpensive and useful source of publications about recent population studies. Most university population centers or institutes issue reprints, usually without charge. Among the agencies that issue them regularly are: the Carolina Population Center, Harvard University's Center for Population Research, the East-West Population Institute, the University of Michigan's Center for Population Studies, and the University of California. More information about these series can be found in the *International Directory of Population Libraries and Information Centers* (Chapel Hill, N.C.: Carolina Population Center, 1972). Commercially published reprints include the following:

Addison Wesley Modules in Anthropology
Addison-Wesley Publishing Company
Reading, Massachusetts 01867

Bobbs-Merrill Reprints in Geography
 Bobbs-Merrill Company
 Indianapolis, Indiana 46268

Scientific American Offprints
 W.H. Freeman and Company
 660 Market Street
 San Francisco, California 94104

ATLASES AND MAPS

Maps are the primary visual tool of the geographer. They are especially useful to the population geographer attempting to communicate the results of his or her statistical or areal research. The following list of books and articles on mapping is necessarily selective, rather than comprehensive.

Atlases

Burgdörfer, Friedrich, ed. *World Atlas of Population*. Hamburg: Falk-Verlag, 1954. Loose-leaf, serial.

Provides dot maps of world and regions. Lists population and density; useful explanatory text. Very hard to find.

Bruk, S.I., ed. *Atlas Narodov Mira* (Atlas of the Peoples of the World). Moscow: Main Administration of Geodesy & Cartography, 1964.

Shows the location and density of 900 ethnic groups. In Russian, with English translation published by Telberg Book Corporation.

Ginsburg, Norton S. *Atlas of Economic Development*. Chicago: University of Chicago Press, 1961 (U.S. \$9.50)

Forty-eight maps devoted to global economic distributions. Ranks by nation each characteristic mapped; helpful for analyzing association or covariance. Invaluable tool.

Spencer, Robert F. and Elden Johnson. *Atlas for Anthropology*. Dubuque, Iowa: W.C. Brown, 1960.

Maps culture and linguistic areas for the world.

Indexes for locating maps

Maps are listed by their publishers in catalogs; if they are published by governments they may be found in any list of government documents. Other sources for new maps are the journals and indexes to new geographical publications. A few of these are mentioned below.

American Geographical Society. Library. *Current Geographical Publications*. New York, 1938—

Bibliographie Cartographique Internationale. Paris: Armand Colin, 1936—. Irregularly.

Journal of Geography. Chicago: National Council for Geographic Education, 1902—. Monthly, except July and August.

Professional Geographer. Washington, D.C.: Association of American Geographers, 1949—. 6 issues per year.

Royal Geographical Society. *New Geographical Literature and Maps*. London: Royal Geographical Society, 1951—. Semiannually.

Map making

- American Society of Photogrammetry. *Manual of Photographic Interpretation*. Washington, D.C., 1960.
- Carey, George W. "Visual Media in Ecological Study." In *Teaching Population Geography*, George W. Carey, ed. New York: Columbia Teachers College Press, 1969.
- Heenan, L.D.B. "The Population Pyramid: a Versatile Research Technique." *The Professional Geographer* 17:18-21, 1965.
- MacKay, J. Ross. "An Analysis of Isopleth and Choropleth Intervals." *Economic Geography* 31:71-81, January 1955.
- Marsh, Susan. *Teaching about Maps*. Darien, Conn.: Teachers Publishing Co., 1965.
- Monkhouse, F.J., and H.R. Wilkinson. *Maps and Diagrams*. London: Methuen, 1964. 2d ed.
- Robinson, Arthur H., and Randall D. Sale. *Elements of Cartography*. New York: J. Wiley & Sons, 1969. 3d ed.
- Steward, John Q., and William Warntz. "Macrogeography and Social Science." *The Geographical Review* 48:167-184, 1958.
- Stokes, George A. "The Aerial Photograph: a Key to the Cultural Landscape." *Journal of Geography* 49:32-40, January 1950.
- Stone, Kirk H. "A Guide to Interpretation and Analysis of Aerial Photos." Association of American Geographers, *Annals* 54:318-328, September 1964.
- Wright, John K. "Problems of Population Mapping." In *Notes on Statistical Mapping*, John K. Wright, ed. New York: American Society of Geographers, 1938, pp. 1-18.

FILMS

The ideal film for use in a population geography curriculum is one that incorporates spatial and demographic concepts, or shows the relationship between human beings and their environment. Most of the existing films have a primary theme of rapid population growth and the social, economic, and environmental problems associated with it. One or two films do focus on such related phenomena as urbanization, migration, the role of women, and land use planning. Films should not be used in place of other teaching methods, but they can provide the springboards for classroom discussion. Since many of the films are quick to draw conclusions or provide solutions to the problems of population growth, opportunity for varying viewpoints must be allowed. A selected list of films recommended by population educators is included below. Wherever possible the purchase price is also given.

Arid Lands. (27 minutes, black and white, sound) 1960. (U.S. \$125.00) Produced for UNESCO by World Wide Pictures.

Economic development and population pressures in the arid lands of the world.

Boomsville. (11 minutes, color, sound) 1969. (U.S. \$150.00) Learning Corporation of America.

Short animated film depicting the historical sequences of modern civilization, especially migration to North America. Little emphasis on population growth but portrays urban growth and related problems. No narration but pictures tell all.

The Danger Signal. (10 minutes, black and white, sound) 1970. Government of India Films Division, Delhi.

Shows in semi-fictional presentation the threat of overpopulation in India and what can be done to prevent it.

The Day before Tomorrow. (25 or 51 minutes, color, sound) 1971. Association Sterling Films. (U.S. \$300.00 or U.S. \$450.00)

Explains the history of population growth patterns, emphasizing present rapid growth patterns throughout the U.S. and the world. Indicates that birth control is the first step toward planning population growth, then describes techniques. Calls for sex education. Alan Guttmacher and Paul Ehrlich present their own views.

The Earth and Mankind Series. (6 films, 28 minutes, black and white, sound) Produced by National Film Board of Canada; distributed by McGraw-Hill, Text-Film Dept.

Part 1. *People by the Billions*

Reasons for and implications of population explosion. Presents alternative solutions without ignoring objectionable social features.

Part 2. *Man and His Resources*

Compares food consumption, housing, diseases, and medical care of "have" and "have-not" nations.

Part 3. *To Each His Rightful Share*

Shows unequal distribution of world's resources, points out why developed nations must help the less developed nations in agricultural and economic development.

Part 4. *The Global Struggle for Food*

Presents attempts to alleviate food shortages through agricultural technology, irrigation, land redistribution, and education.

Part 5. *Can the Earth Provide?*

Emphasizes the role of conservation and research in increasing food for the world. Shows cultural problems involved in diet changes.

Part 6. *Challenge to Mankind*

Group discussion of the threat of overpopulation to mankind; panel represents four continents and varied religions.

Economic Geography: Three Families in Different Environments. (14 minutes, color, sound) 1971. (U.S. \$205.00) Produced by BFA Educational Media.

Portrays the ways in which three families in different environments have dealt with their environments. Rain forest, Western rural, and Western urban situations are shown in clear photographic imagery. Sound is excellent. Recommended for upper school grades but might be as suitable for beginning course in population geography.

Family Planning in Taiwan. (25 minutes, black and white, sound) 1969. Taichung, Taiwan Film Studio.

Included because it shows the geographic conditions that must be considered when organizing a family planning program.

House of Man: Our Changing Environment. (17 minutes, color, sound) 1965. Encyclopedia Britannica Educational Corporation.

Contrasts the natural ecosystem of a pond with man's created environment, the city. Poses question whether problems of urban sprawl, pollution, and slums are a necessary adjunct to urbanization and suggests that with adequate planning they are not. Traces the history of world population growth and resource use, and presents a non-economic value orientation.

Mauritius. (30 minutes, black and white, sound) 1965? Planned Parenthood—World Population Audio-Visual Service.

Entire film devoted to the population explosion on the island of Mauritius in the Indian Ocean. Shows economic, social, and spatial repercussions of too many

people. Viewers can also see it as what can happen to the planet Earth through uncontrolled population growth.

Multiply and Subdue the Earth. (60 minutes, black and white or color, sound) 1967. (U.S. \$270.00 or \$450.00) Indiana University Audio-Visual Center.

Emphasizes land as our principal resource and advises wise use of it. Criticizes economic gain as criterion for land use. Case studies of New Jersey, Hawaii, Tahoe, and others.

Nineteen-Eighty-Five (1985). (60 minutes, color, sound) 1970. (U.S. \$500.00) CCM Film Corporation.

Uses the medium of a newscast to describe the total devastation of the environment in the year 1985 through pollution, famine, and an energy failure. The newscasts show actual scenes from contemporary life as if they were the cause of the collapse; verisimilitude is sustained throughout the film.

Paradise in Peril. (45 minutes, color, sound) 1975. (U.S. \$300.00) Suva, Fiji: Government of Fiji, Film Division.

Presents the problems of a multiethnic population competing for finite resources of an island ecosystem.

Population Ecology. (19 minutes, color, sound) 1964. (U.S. \$232.00)

Demonstrates how population growth occurs in a variety of organisms, first showing lab demonstrations of different animal responses to the same environmental limits. Portrays fluctuations and limitations of population sizes as the environment changes. Explains population growth curve through the history of man. Makes point that man, too, is governed by natural laws and that population will be limited by starvation, war, disease, or control.

Population Problem Series. (30 or 60 minutes, black and white, sound) 1965. Produced by National Educational Television; distributed by Indiana University.

Brazil: The Gathering Millions

Examines Brazil's urban population boom and the rapid population decrease in the rural areas. Overpopulation is shown in an urban context.

The European Experience

Excellent portrayal of the demographic transition in Europe, using contemporary art to illustrate historical facts.

Gift of Choice

Ways in which science is able to assure that every family can achieve its desired size are the subject of the concluding film in the Population Problem Series.

India: Writings in the Sand

Details the effects of India's uncontrolled population growth on her economy. Focuses on cultural and religious resistance to change and describes family planning efforts since 1965. Fosters better understanding of the causes and consequences of population growth in Indian society.

Japan: Answer in the Orient

Shows how Japan became the first non-Western country in the post-World War II era to lower its birth rate to prevent the overpopulation situation. Explains how this was possible.

U.S.A.: Seeds of Change

Points directly to the reasons why the United States cannot ignore its own population problem as revealed in congestion, inner-city life, slums, migration to suburbs, pollution.

A Single Step. (28 minutes, color, sound) Produced for Planned Parenthood—World Population.

Discusses ecology and population problems and what college and university students can do about environmental problems. Designed for teachers and students.

The Squeeze. (10 minutes, black and white, sound) 1969. Hilary-Harris Films, Inc.

Shows consequences of the population explosion as illustrated by crowded streets, suburbs, slums, beaches, hospitals, etc.

3900 Million and One. (45 minutes, color, sound) 1975. (U.S. \$600.00) London: Oxfam.

Describes the traditional village culture in rural India and the responses of the men and women to family planning programs. Filmed in India.

The Time of Man. (50 minutes, color, sound) 1971. (U.S. \$450.00) Holt, Rinehard & Winston Media Sales.

Reviews man's evolutionary history and looks at primates in their natural surroundings. Shows how human beings interact with their environment in Africa and New Guinea without disturbing the balance of nature. The main theme is man's reliance on a supportive ecosystem. Ends with a 10 minute flashback of man's activities over the past 60 years as he has intruded into the natural systems. Population stabilization is indicated as the way to regain the natural balance.

Tragedy of the Commons. (23 minutes, color, sound) 1971. (U.S. \$295.00) King Screen Productions.

Emphasizes population growth initially through the overgrazed commons pasture, then through the degradation of urban life. Asserts that population must be controlled, even when the individual's right must give way to the common good.

FILM STRIPS AND SLIDES

Issues in Population: Where the Experts Disagree. (videotape, 30 minutes; slides with audio cassette, 30 minutes; or film strip with audio cassette, 30 minutes) Cornell University Population Program. (U.S. \$22.00)

Experts in population, agriculture, and other fields give their opinions on what can be done to limit world population growth.

The People Problem. (filmstrip and two records in 2 pts., approximately 90 frames each, runs 28 minutes) Guidance Associates, Pleasantville, N.Y. (U.S. \$35.00)

Uses beautiful color slides to show the population problem around the world and in U.S. Includes interviews with Drs. Bernard Berelson and Alan Guttmacher.

Population Explosion. (51 frames, black and white) 1967. New York Times Book & Education-Audio-Visual. (U.S. \$6.00)

Silent filmstrip with captions and a discussion manual. Shows the effect of population growth on poverty, hunger, illiteracy, and political instability. Focuses on less developed areas of Asia and Africa.

Population Reference Bureau, Inc.

Produces slides for very reasonable prices to accompany their *Population Bulletins*. Has series of 23 slides entitled *Man's Population Predicament*. Write for list.

World Law Fund, 11 West 42nd Street, New York, New York 10036.

Audiovisual materials on population as well as games and course outlines. List supplied upon request.

AUDIO TAPES AND CASSETTES

Several companies produce audio tapes or cassettes having a population theme, some of

which are listed in *Teaching Notes on Population* in the Spring/Summer, Fall/Winter 1973 issues. Those relevant to population geography are listed here.

Bombay. (cassette, 30 minutes) CBC Learning Systems. (U.S. \$5.00)

Broadcaster Mawbool Jung does a portrait in sound of her city, Bombay. Conveys a sense of population in the city, with all its good and bad effects.

Green Revolution. (cassette or reel, 26 minutes) Center for the Study of Democratic Institutions. (U.S. \$7.50)

An explanation of why developing nations might adopt the Chinese model of economic development, and what role U.S. foreign aid might play.

Issues in Population: Where the Experts Disagree. (See section on film strips and slides.)

Population and Migration. (cassette, 35 minutes) Center for Cassette Studies. (U.S. \$14.95)

Dr. Harry Shapiro talks about the influx of people to Hawaii and the effects of immigration; Shapiro and Walter Fairervis then discuss a similar event that occurred in Iran 4000 years ago.

Shoulder to Shoulder. (cassette, 23 minutes) Center for Cassette Studies. (U.S. \$12.95)

Explores the world population crisis from a statistical perspective; the opinions of population and ecology specialists are heard.

Urbanizing in the Developing Countries. (cassette, 30 minutes) CBC Learning Systems. (U.S. \$6.00)

Dr. Peter Gutkind of McGill University, Canada, talks about population growth in the agricultural economies of Africa and Asia.

ORGANIZATIONS

A number of agencies are engaged in research on demography and population problems at the national and international level. Those listed below provide materials on population and population education free or at nominal cost.

Center for Information on America

Box C, Washington, Conn. 06793

An independent, nonprofit educational corporation dedicated to furthering knowledge about the United States through publications, radio, films, television, and conferences. It has published a series of *Population Profiles*, edited by Everett Lee, reporting on population issues in the United States. The series of 14 units includes study guides and bibliographies designed for use in high schools and junior colleges. The series is a good example of inexpensive course materials that might be copied by other countries.

The Ford Foundation

320 East 43rd Street, New York, N.Y. 10017

Population program was established in 1952. Activities include support for training and research in reproductive biology, population research in universities or institutes, and population programs in developing countries. The Foundation's *Annual Report* describes its activities.

Institute of Population Studies

Chulalongkorn University, Ratasatr Building 3, Bangkok 5, Thailand

Publishes working papers and monographs on Thai demography.

International Institute for Population Studies

Bombay 400088, India

Conducts research on population topics and publishes monographs.

International Planned Parenthood Federation
51 East 42nd Street, New York, N.Y. 10017
18-20 Regent Street, London, England

IPPF was established in 1952; it has regional offices in Europe and the Near East, Southeast Asia and Oceania, the Indian Ocean, and Western Pacific and Africa. Its activities include training for doctors, nurses, social workers, and public health experts in the administration and creation of family planning associations throughout the world. It also promotes research on human reproduction and birth control, and it publishes a number of newsletters, bibliographies, and monographs that may be obtained at little or no cost. *IPPF News*, *Research in Reproduction*, and *Situation Reports* are among their best-known publications.

Organization for Economic Cooperation and Development
Development Centre, Paris, France

The Population Division of the OECD has been active in the publication of studies on labor supply, population and economic development, and family planning programs. The *OECD News* and a list of OECD publications are free upon request.

Pakistan Institute of Development Economics
P.O. Box 1091, Islamabad, Pakistan

Conducts demographic surveys and publishes series on population, economic development, and migration.

Planned Parenthood—World Population
810 Seventh Avenue, New York, N.Y. 10019

A private organization dedicated to maintaining stable populations in optimum environments. It conducts extensive public information and training programs for professionals, and distributes literature and films on family planning, family life, human sexuality, and population. Its publications include *Family Planning Perspectives*; *Family Planning in Five Continents*; *U.S. Population and Family Planning: A Review of the Literature*; *Guide to Films*; *Guide to Information Sources in the Fields of Population, Family Planning*; and *Publications about Planned Parenthood*. Most publications are free, and multiple copies are available for classroom use.

Population Center Foundation
Makati, Rizal, Philippines

An informational and educational agency involved in population projects for the Philippines. Distributes materials free to other agencies in the field.

The Population Council
245 Park Avenue, New York, N.Y. 10017

Organized in 1952 as a nonprofit agency for scientific training and study in population. The Council endeavors to advance knowledge in the broad field of population by fostering research, training, and technical consultation and assistance in the social and biomedical sciences on an international level. It has been active in the population education movement since the 1960s, and has aided in curriculum development, communication, and publication of the *Teaching Notes on Population*. Serial publications of the Council include *Country Profiles*, *Population and Development Review*, *Reports on Population/Family Planning*, *Studies in Family Planning*, *Population Monographs*, and several book lists. They are available free of charge.

The Population Reference Bureau
1337 Connecticut Avenue NW, Washington, D.C. 20036

One of the first private organizations to be concerned with population matters, the PRB was set up in 1929 to educate the public about population growth and demographic trends. Its active role in the field of population education is reflected in its serial publications—*Population Bulletin*, *PRB Selection*, *Population Profile*, *World*.

Southeast Asia Regional Population Research Awards Program

International Development Research Centre, Tanglin P.O. Box 101, Singapore 10

Provides research awards to young Asian social scientists from Burma, Indonesia, Khmer Republic, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Publishes research reports on demographic topics.

United Nations

New York, N.Y. 10017

The U.N. and its agencies publish various materials on population and related issues. The Population Division of the U.N. is one of the world's most reliable sources of demographic information, published in its Working Papers, *Population Studies Series*, and *Population Bulletins* 1-7. The Statistical Office produces the annual *Demographic Yearbook* and *Statistical Yearbook*, used by every researcher. Its *Handbooks on Vital Statistics Methods* and *Manuals for Estimating Population* are widely used, as is the *Demographic Dictionary*. The U.N. Fund for Population Activities (UNFPA) was created in 1967 to help developing countries with their population problems, to expand the population activities of the U.N. system, and to pursue innovative programs in the field. It also encourages greater coordination between U.N.-supported activities and those of governmental and private organizations. Also concerned with population aspects are the Economic and Social Commission for Asia and the Pacific (ESCAP); the Food and Agriculture Organization (FAO); the U.N. Educational, Scientific, and Cultural Organization (UNESCO); and the International Labor Organization (ILO). Representative publications of interest include the *Asian Population Studies Series*, published in Bangkok; *Population and Family Education*; and *Draft Sample Instructional Materials: Social Studies*. Publications are available from the United Nations Sales Division, New York, N.Y. 10017, or UNIPUB, P.O. Box 433, Murray Hill Station, New York, N.Y. 10016.

United States, Bureau of the Census

One of the largest publishers of census data is the U.S. Bureau of the Census. Teachers interested in classroom materials can obtain a series of booklets on the 1970 census for classroom use. These are descriptive, pictorial, graphic explanations of population changes during the 1960-1970 decade. Other publications are the *Statistical Abstract*, *City and County Data Book*, and *Pocket Data Book: USA 1972*; the last is a handy collection of vital statistics. All publications are available through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The World Bank Group

1818 H Street, N.W., Washington, D.C. 20433

Three agencies are in this group: the International Bank for Reconstruction and Development, the International Development Association, and the International Finance Corporation. They provide a range of financial services to developing countries and have U.N. status. Many of their publications are highly technical monographs but several would be useful for classroom teaching, in particular *World Bank Atlas* and *Trends in Developing Countries*; both include good population graphics.

Zero Population Growth

4080 Fabian Way, Palo Alto, Calif. 94303

A nonprofit membership organization formed in 1968 to work for stabilization of the U.S. population. It has over 300 chapters that concentrate on lobbying, education of the public, and support for population-informed candidates. It distributes free packages to teachers, with annotations of selected books and films, news about curriculum development, teachers' guides and resource lists, and information on contraception and abortion. Members receive the monthly *ZPG Reporter* and *Equilibrium*. (Subscription fee \$15.00 per year.)

2

Analysis of the Spatial Concentration of Population

Population geographers have probably been remiss in not adopting many of the tools of economic and quantitative geography. This section briefly notes the relevance of various quantitative techniques—from simple location quotients to measures of entropy—to the study of population. These tools can be used for classroom or laboratory exercises by the addition of original data appropriate to the level and setting of the course.

Whereas the demographer may be concerned with fertility rates, mortality rates, and population dynamics derived from them (e.g., net reproduction rates), it is the more specific concern of the population geographer to examine these variables within the context of specific places, to describe the patterns which these variables manifest over space, and to seek to understand the processes which have generated the patterns. Of particular concern to the population geographer is the problem of measuring patterns of population concentration. Measures and statistics have been designed specifically for the analysis of relative concentration. The term "relative" must be emphasized. Let us assume we have a list of population densities for the provinces of Thailand from which one can quickly ascertain differences in population density. But if one is interested in the degree of divergence exhibited by each province from the population density of the nation as a whole, these ratios allow only a partial solution to the problem of analyzing relative densities.

THE LOCATION QUOTIENT

The location quotient (LQ_i) is a measure of concentration that is useful in answering questions of relative density. It is calculated by dividing the regional ratio by the national ratio. This calculation may be stated:

$$LQ_i = (a_i/b_i)/(A/B)$$

where a_i = the value of the regional experimental variable, e.g., population of province i .

b_i = the value of the regional referent variable, e.g., area of province i .

A = the national experimental value, e.g., population of Thailand.

B = the national referent value, e.g., area of Thailand.

If the $LQ_i = 1.00$ the region shows the same ratio as the nation and can be considered to have an average concentration of population density. If the value ranges from zero to something less than 1.00 ($LQ_i < 1.00$), the region can be considered to have a dearth of density, or less than average density. If the value of the LQ exceeds 1.00 ($LQ_i > 1.00$),

the province exhibits a greater than average or an abundance of density concentration. Location quotients for other areal units can be calculated in this manner.

Often the LQ is calculated in such a way that the experimental variable is some proportion of the referent variable. For example, one may wish to know the concentration of Chinese population by the provinces of Malaysia. An LQ calculated for this purpose would have the number of Chinese as the a variable and total population as the b variable, resulting in a property called an inclusive referent. The a value could never exceed the b value. In this example the Chinese population is simply a subcategory of the total population. Many variables of interest in population geography can be cast in LQ s with inclusive referents.

All LQ s, those with and without inclusive referents, are at best an ordinal measure of concentration. While the dearth scores can range only between 0.00 and 1.00, the abundance scores can have values greater than 2.00 and are limited only by the total variability in the data. Thus, it is possible to conclude only that a particular area has a greater or lesser dearth (or abundance) than another area. It is not possible by the LQ measure to conclude *how much* greater, or lesser, the dearth (or abundance) may be.

THE m -SCORE

As we noted earlier, the LQ applies only to ordinal data. If the LQ has an inclusive referent, however, it can be modified in such a way that interval-level concentration scores result. These are called m -scores, and their calculation and rationale follow.

When investigating concentration, we divide a single continuum of proportions, from zero to unity, into two separate unities, one for dearth (proportion 0.00 to A/B) and another for abundance (A/B to 1.00). Using the Chinese population in the provinces of Malaysia for example, we array the proportions of Chinese by province (a_i/b_i) on that original continuum. The value used to divide it is the proportion of Chinese in the total Malay-

Province	Chinese population		Total population		d_i
	a_i	A	b_i	B	
X	0	506,200	21,212	6,227,300	-34
Y	27	506,200	1,281,012	6,227,300	-20.565

sian population (A/B). Dearth values exist when $a_i/b_i < A/B$, and abundance is present when $a_i/b_i > A/B$. The dearth unity, then, is between the minimum LQ possible and an LQ of 1.00, and the abundance unity consists of those LQ s above 1.00. As shown earlier, the reason for the ordinal nature of LQ scores is their open limit on the abundance unity. If that unity could be closed it would be possible to express both scarcity and surplus in terms of relative deviation from average concentration on their respective unities, thus creating an interval measure.

If the referent is inclusive, the most extreme concentration score exists when all of the experimental variable in a nation is in a single province and the value of this variable constitutes the total referent score for that province—i.e., $a_i = b_i = A$. Substituting these equalities into the LQ formula results in the following:

$$LQ_i = (a_i/b_i)/(A/B)$$

$$LQ_{\max} = 1/(A/B)$$

$$\text{if } a_i = b_i = A$$

$$LQ_{\max} = B/A$$

If the actual LQ for place i equals the $LQ_{\max}$, a ratio of the two computes to 1.00. Thus an abundance unity limit is set. Although the condition of $a_i = b_i = A$ was specified for this parameter, it will take the same value only if $a_i = b_i$. The full limit formula, designated $m_{\max}$, is $LQ_i/LQ_{\max}$ when $a_i = b_i = A$. Substituting the LQ_i formula into the equation and holding constant only the condition $a_i = b_i$ results in the following:

$$m_{\max} = ((a_i/b_i)/(A/B))/(A/B).$$

This equation can be reduced to:

$$m_{\max} = ((a_i B)/(b_i A))/(A/B)$$

$$= (a_i B/b_i A)/(B/A)$$

$$= a_i B A / b_i A B$$

$$= a_i / b_i.$$

Thus all places where 100 percent of the population is of a specified ethnic character will take m -scores of 1.00. The triple equality is not necessary to reach the greatest concentration possible on the scale, though this situation would certainly reach the abundance limit.

Beyond having established this parameter and the score value of 1.00 associated with it, it is necessary to state the calculation of intermediate abundance scores in such a way that they represent positive deviation on the abundance unity only. This calculation can be expressed as:

$$m_i = ((a_i/b_i) - (A/B))/(1 - A/B) \quad \text{if } LQ_i > 1.00.$$

The $(a_i/b_i) - (A/B)$ term expresses the level of the abundance unity to which region i has penetrated. The $(1 - A/B)$ term is the range of proportions that fall into that unity. When $a_i = b_i$, the limit of 1.00 for m_i will be reached because the terms in the right of the equation will be identical. When $a_i/b_i = A/B$, the m -score will be zero, for $a_i/b_i - A/B = 0$. The m_i will necessarily be zero. Abundance m -scores will then range from 0.00, for average concentration, to 1.00, for total concentration.

Locating an m -score on the dearth unity can be done in a more direct manner. The dearth m -score is:

$$m_i = LQ_i - 1.00$$

$$\text{if } LQ_i \leq 1.00.$$

The most extreme dearth score possible is -1.00. This will occur when none of the experimental variable is present. An average m -score takes the value of 0.00; i.e., when $LQ_i = 1.00$ then $m_i = 0.00$. Thus the extreme high of the dearth unity and extreme low of the abundance unity converge at 0.00 and concentration on the m -scale is measured between limits of ± 1.00 .

The formula for the dearth m -value is facilitated in that LQ s from scarcity to average concentration are already scored on a unity from 0.00 to 1.00. That unity is moved between the score ranges of -1.00 to 0.00 by subtraction of 1.00. Simultaneously, as dearth m 's are absolute complements of their associated LQ s, the scores are set to diverge from average concentration.

This procedure has the effect of making the m -scale an interval measure of concentration. A dearth m_i of $-.33$ is exactly the same relative scalar deviation in concentration from average as an abundance m_i of $+.33$. They are also $.66$ units of concentration apart. There is no compelling reason why these scores are not additive, hence the conditions for an interval level of data are met. As may be inferred from this discussion, the m -score is a superior measure of concentration to the others presented because it is a valid measure of interval data.

NEAREST NEIGHBOR AND QUADRAT ANALYSIS

Analysis of concentration of patterns of demographic variables in geography has taken two forms: analysis of concentration patterns of settlements, or discrete place locations, and the analysis of continuous space concentrations of demographic subgroups, e.g., the Chinese population in Malaysia. The former type of analysis will be discussed first because of its greater emphasis in the geographical literature; the latter has received less attention within population geography.

Three types of statistical technique have been applied to concentration-pattern analysis of settlements: (1) the nearest neighbor statistic, (2) quadrat analysis, and (3) entropy expressions of quadrat analysis. All of these techniques test statistically the difference in concentration from a totally dispersed pattern. These tests generally use a null hypothesis of no significant divergence from regular location and a rejection area of random locational posture. The nearest neighbor is also used here as a descriptive statistic. This type of application will be detailed here.

The nearest neighbor statistic was developed originally by plant ecologists to measure concentration and dispersion in plant populations. It has subsequently been adopted and further developed by geographers in settlement pattern analysis. In preparing for calculation one must first search the map of settlements under investigation for distances between nearest neighbor pairs. These distances are the basic input for the computations. Each place (i) in the pattern has a single nearest neighbor (j); the nearest neighbor is identified, as the name implies, when the distance between place i and j is minimized. Some nearest neighbor pairs are termed reflexive. These are ones which are reciprocally the nearest neighbor for the other. For example, as shown below, C and D are reflexive nearest neighbors, whereas A and B are not.

E	A	B	C	D
---	---	---	---	---

C is D 's nearest neighbor and vice versa, but while A is B 's nearest neighbor, B is not A 's. Once all nearest neighbor distances have been measured, the statistic, commonly designated R_N , may be calculated as follows:

$$R_N = \frac{2\bar{d}\sqrt{N}}{\sqrt{A}}$$

where $\bar{d}$ = the average of the nearest neighbor distance

N = the number of places

A = the area (in units comparable to the nearest neighbor distances) of the region under investigation.

If $R_N = 0.00$ the places are clustered in a single location. A value of around 1.00 is generally considered to indicate a random placement of settlements, and the highest value the statistic takes is 2.15.

It is possible to determine the sampling distribution for a pattern of locations; hence one can test for the statistical significance of deviation from a random pattern using a *t*-test. One may also use a one-tailed test to determine the statistical significance of deviations from a uniform pattern. Readers interested in these procedures are referred to Dacey (1962).

Whether using R_N as a descriptive or as an inferential statistic one must keep in mind its limitations. When one concludes that a pattern of places is random it is so only with regard to its internal spatial relationships. For example, a group of settlements may be arranged along a railroad track and, as the track meanders, appear to be randomly placed in the internal distance relationships. In this instance it is clear that the settlement pattern is highly correlated with another variable in the landscape, the transportation route. Although it is random in terms of nearest neighbor pairs, it is not random in relation to the railroad.

Thus, it must be kept in mind that nearest neighbor analysis is applicable only to the variables one is using to explain the pattern of locations. Christaller has theorized that marketing forces, if undisturbed by other factors, would lead to a uniform array of places. It is germane in examining this premise to ask to what degree a place pattern diverges from uniformity. Alternatively one may wish to know whether people who share a characteristic (e.g., a language) are concentrated spatially within a larger population. One would then be interested in the pattern of divergence from a clustered arrangement. The assertion would be supported if the R_N was near 0.00, and refuted if higher scores appeared.

When using the nearest neighbor statistic, it is seldom that one is looking for a random spatial pattern. The types of hypotheses that can be most usefully tested by it are those concerning divergence from either of its poles, uniform or clustered patterns. Which one of these poles one wishes to investigate depends on the theory being applied to explain the pattern. If there are no theoretical reasons to believe a group of locations being analyzed should be either clustered or uniformly spaced, this statistic is probably inappropriate to the investigation.

Quadrat analysis is another approach to the evaluation of regular or clustered place patterns. It has been applied where there are many places and the search and measurement of nearest-neighbor pairs are extremely cumbersome, and where population loadings in addition to place locations are under question. Statistically it takes the form of a frequency *chi*-square test.

GINI COEFFICIENTS AND LORENZ CURVES

The Gini coefficient is a method for ascertaining the degree of divergence that a Lorenz curve is from a linear relationship between the experimental and referent variables. The construction of a Lorenz curve is described elsewhere (Szule, 1965:236–240). The Gini coefficient (GC) is useful for analyzing noninclusive referents. The computation of a GC is quite tedious, however, involving cumulative rankings and interpolation procedures, and it results in only an estimate of the area under the curve. Statistical tests for deviation from complete dispersion can be made, in a goodness-of-fit manner, but one must keep the approximate nature of the GC in mind when applying this index.

A major weakness of this index for spatial analysis is that subregions that are spatially identical in concentration—e.g., those with none of the experimental variable or with the experimental variable equal to the referent—make varying contributions to the

GC. In all instances where the value of the experimental variable is zero, and the cumulative proportion is thus zero, the curve is extended along the x-axis by the proportion of the referent variable in the region. Thus, though both subregions show no concentration, the one accounting for the greater proportion of the referent should cause greater deviation from average than the one accounting for the lesser proportion. Spatially they are both void areas, but statistically they are considered to make different contributions to the concentration pattern when Gini coefficients and Lorenz curves are used.

ENTROPY MEASURES OF CONCENTRATION FOR CONTINUOUS DISTRIBUTIONS

An entropy measure of concentration in continuous space distributions is designated as the G index. It is expressed as:

$$G = \frac{H}{\ln k}$$

where H = the degree of uncertainty (entropy) in a group of places in their ability to attract concentration

k = the number of i th places

Theoretically if H equals $\ln k$ this is the greatest entropy possible. Thus, if G equals 1.00 the experimental variable is totally dispersed, if it equals 0.00 the variable is concentrated in a single subregion, and scores in between reflect intermediate degrees of concentration.

H must be calculated prior to G . It is formulated for population problems as:

$$H = -\sum_{i=1}^k p_i \ln p_i$$

where p_i represents the relative attractive force of the region, i.e., the probability of its attracting some of the experimental variable. Where all regions are equally attractive $H = \ln k$. Thus G is constituted as the ratio of actual entropy to entropy expected if the distribution is totally dispersed, hence each subregion equally attractive.

Although the G index is superficially attractive for segregation analysis, one must bear in mind that, as the index is currently elaborated, there is no statistical test for changes in G . It is therefore only a descriptive measure at this point. Moreover, it provides no measure of concentration at the i th places.

THE M STATISTIC

The final index of concentration to be presented here is the M statistic. It can be used with given enumeration districts and is the simple mean of m -scores for a set of places. Formally it is expressed as:

$$M = \frac{\sum_{i=1}^n m_i}{n}$$

where m_i = the m -score for subregion i

n = the number of subregions.

This index, like its component m -scores, is bounded by ± 1.00 . Complete dispersion is indicated by 0.00. Scores from -1.00 to 0.00 indicate a concentration pattern in which many subregions have dearths of the experimental variable and few exhibit abundance.

Scores from 0.00 to +1.00 indicate that the average subregion has an abundance of the experimental variable and few subregions have none of it.

Because M is a mean its sampling distribution can be considered to be normal. Any test that can be used with Pearson's r can be applied to the M because the sampling distribution is normal; the limits are ± 1.00 ; the conceptual average dispersion, 0.00, sits at the middle of the scale; and these are the characteristics of the ρ distribution. It is possible using the t - and z -tests to examine the statistical significance of the deviation of a distribution from complete dispersion or from another array.

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3

Demography of Early Populations and the Boserup Thesis

Thomas Robert Malthus is usually credited with initiating scholarly concern about the problems of population growth. In 1798 Malthus postulated that population growth would outstrip the ability of the land to provide an adequate food supply (Malthus, 1965). This basic concern is held by many today; indeed, Malthusian thinking is the foundation for the population policies of many nations in the Asia/Pacific region.

Ester Boserup is among the relatively small number of population scholars who have considered the advantages of rapid population growth. Her writings on agricultural growth have attracted the attention of population geographers in particular, and have become required course readings in several geography departments in the Asia-Pacific region. It has become common (if not completely accurate) for geographers to treat Malthusianism and the Boserup thesis as a dichotomy; Malthusians see rapid population growth as a threat, whereas advocates of Boserup see rapid population growth as a precondition for technological advance. This question of threat or precondition, though it cannot now be answered definitively, is central to the study of population today.

*The following essay attempts to refute the Boserup thesis. It should be read in conjunction with Boserup's *The Conditions of Agricultural Growth* and perhaps with Malthus's essays on population growth. These materials can form a first unit on population problems and expose the student to basic philosophical issues and some lively discussion.*

After examining the relationship between the growth of historic populations and increases in their food supply, Ester Boserup (1965:118) concluded:

... population increase leads to the adoption of more intensive systems of agriculture in primitive communities and an increase of total agricultural output. This process, however, can hardly be described as economic growth in the generally accepted sense of the term, since the proximate effect upon output per man-hour is to lower it. But sustained growth of total population and of total output in a given territory has secondary effects which—at least in some cases—can set off a genuine process of economic growth, with rising output per man-hour, first in non-agricultural activities and later in agriculture.

Boserup's thesis assumes that population increase results in higher population density because of effective limits on available land. Those limits may be environmental (e.g., insularity or oasis isolation) or human (e.g., powerful and unfriendly neighbors) in origin.

By concluding that population pressure induced technological advance and higher levels of agricultural intensification, Boserup adopts an anti-Malthusian stance. To her,

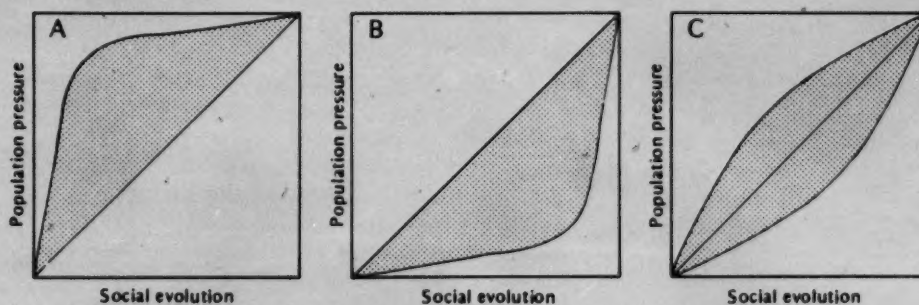
population growth is a prerequisite to increased agricultural productivity; to Malthus, improved agricultural yields are a prerequisite to population growth. A close inspection of the two positions reveals that they are not necessarily incompatible. But they do emphasize opposing roles for the same variables in a cause-effect relationship.

This essay will address the question of whether it is likely that population growth initiates technological change and agricultural intensification. The main emphasis will be on developing a perspective from which it will be possible to evaluate Boserup's work objectively. A demographic approach will be offered as an alternative to her economic approach, and the viability of each will be challenged by the other. The demographic approach as developed herein does not supply a satisfactory alternative explanation of why the growth of a human population should lead to higher levels of agricultural intensification when empirical evidence suggests that in the short run it will lead to lower per capita output.¹ Boserup's argument does explain this phenomenon satisfactorily, and such an accomplishment should be given its due recognition. Nevertheless, her argument is only a logical construct—a hypothesis—that has yet to be proven valid. If it can be shown that her thesis is founded on questionable assumptions, then the attractiveness of her hypothesis will be diminished and a search for an alternative explanation of this economic paradox will be in order.

THE BOSERUP THESIS

In an indirect manner, the Boserup thesis obtains significant support from an intriguing research effort that deals with the likelihood that population pressure causes the social evolution of agriculturalists. Michael Harner (1970) tested this thesis by assuming that if a causal relationship exists between population pressure and social evolution it would take one of the three forms outlined in Figure 3-1. Harner then assumed that if one of two

FIGURE 3-1. Possible relationships between social evolution and population pressure



variables is causal and the other dependent, the causal variable will exhibit a shift in value in advance of the dependent variable. That being so, Figure 3-1A suggests that population pressure is causal whereas Figure 3-1B indicates that social evolution is causal. Figure 3-1C shows a clear relationship between the two variables, but neither variable tends to shift before the other, suggesting that both variables are influenced by some unconsidered exogenous factor.

¹ It is assumed that the evidence marshalled by Boserup does support her contention that population growth leads to agricultural intensification. One of her most important sources of documentation is Haswell (1953).

Harner tested his hypothesis that population pressure causes social evolution by selecting demographic and social data on more than 1,100 tribal groups and graphing them to see if they "fit" any of the three patterns illustrated above. He found that his data matched the pattern shown in Figure 3-1A and therefore concluded that his hypothesis was correct.

If population pressure does indeed cause social change, then it probably has the potential to generate technological innovation and agricultural intensification as well. Unfortunately, Harner had to use surrogate variables to describe population pressure and social evolution. For population pressure he used a measure of the amount of dependence on hunting and gathering. But this variable is really a measure of agricultural intensification, and thus it may be intensification of agriculture itself that causes social evolution, not population pressure.

THE CONTEMPORARY BIAS

In spite of their differences, Malthus and Boserup both view population as having a propensity to grow. Malthus makes an explicit statement to this effect; Boserup merely implies it. Their agreement reflects a bias in the contemporary view of population dynamics. The fact that the world population has, over the past two centuries and particularly during the last few decades, shown a marked tendency to multiply has encouraged people today to view population growth as a natural phenomenon. Furthermore, because of the extraordinary global success in postponing mortality, death is now viewed more as an unavoidable feature of old age than as a powerful determinant of population growth or decline. In today's world, such a view is justifiable since mortality rates have declined to such low levels that population growth is regulated almost entirely by the levels of fertility.² In yesterday's world, different conditions prevailed.

The contemporary view of population dynamics, then, contains two basic distortions: (1) population growth is equated with fertility, and (2) population is viewed as having a natural tendency to grow. In fact, population change in a closed population is the net result of fertility *and* mortality. As long as this fact is kept in mind, it is obvious that population growth is no more "natural" than population decline. Perhaps it would be more accurate to say that both growth and decline are natural and that population stability is not. Consequently, stability must be imposed by a "counteraction" of environmental and cultural forces.³ Much of the persuasiveness of the Boserup thesis derives from this modern belief that persistent population growth is the inevitable consequence of couples' inability to effectively limit their own fertility. We will show that in historic and prehistoric times population growth was not inevitable and that the need to substantially limit fertility probably did not exist. From that perspective, the Boserup thesis will be somewhat less convincing.

Returning to the question of population growth and decline, we should emphasize two points before proceeding to a discussion of prehistoric and historic demography. First, there is a maximum rate of growth which, although impossible to define exactly, probably

2 The current world demographic situation is nicely laid out by Stolnitz (1964).

3 Malthusian pessimism is the belief that cultural forces generally favor population growth and that eventually environmental forces will have to reestablish the necessary stability in a manner unpalatable to humankind. Boserupian optimism, on the other hand, is the view that population stability can be achieved within a wide range of population sizes and that cultural innovation, spurred by population growth itself, continually shifts the upper limit of that range to higher and higher levels.

lies well below the 5 percent per annum level. In contrast, population decline has the potential to achieve much higher rates. It can rapidly diminish a population, whereas growth can only gradually increase it. Second, a population does not automatically seek stability. This fact seems to be obvious even in the modern context, in which fertility and mortality are basically separate phenomena. In contemporary populations, neither fertility nor mortality exercises any great influence on the other. In earlier times, however, mortality had a very important inverse effect on fertility. Owing to the frequency of death in the younger years of life, an increase in mortality would almost certainly mean a decrease in fertility and vice versa. The existence of this relationship would exacerbate the instability of a population's size.

POPULATION DYNAMICS IN PRE-COLUMBIAN TIMES

The equation of fertility with population growth is neatly stated by A.D. Hope, who wrote:

No hunter of the Age of Fable
Had need to buckle in his belt.
More game than he was ever able
To take ran wild upon the veldt;
Each night with roast he stocked his table,
Then procreated on the pelt,
And that is how, of course, there came,
At last to be more men than game.⁴

In fact, human beings became so numerous only after thousands of years of "trying." It has been estimated that during the Neolithic era world population growth must have been on the order of one or two tenths of 1 percent per year (Carneiro and Hilse, 1966; Barringer, 1966). This is hardly an explosive rate. At an annual growth rate of 0.1 percent a village of 100 people would reach a population of 101 in about ten years.

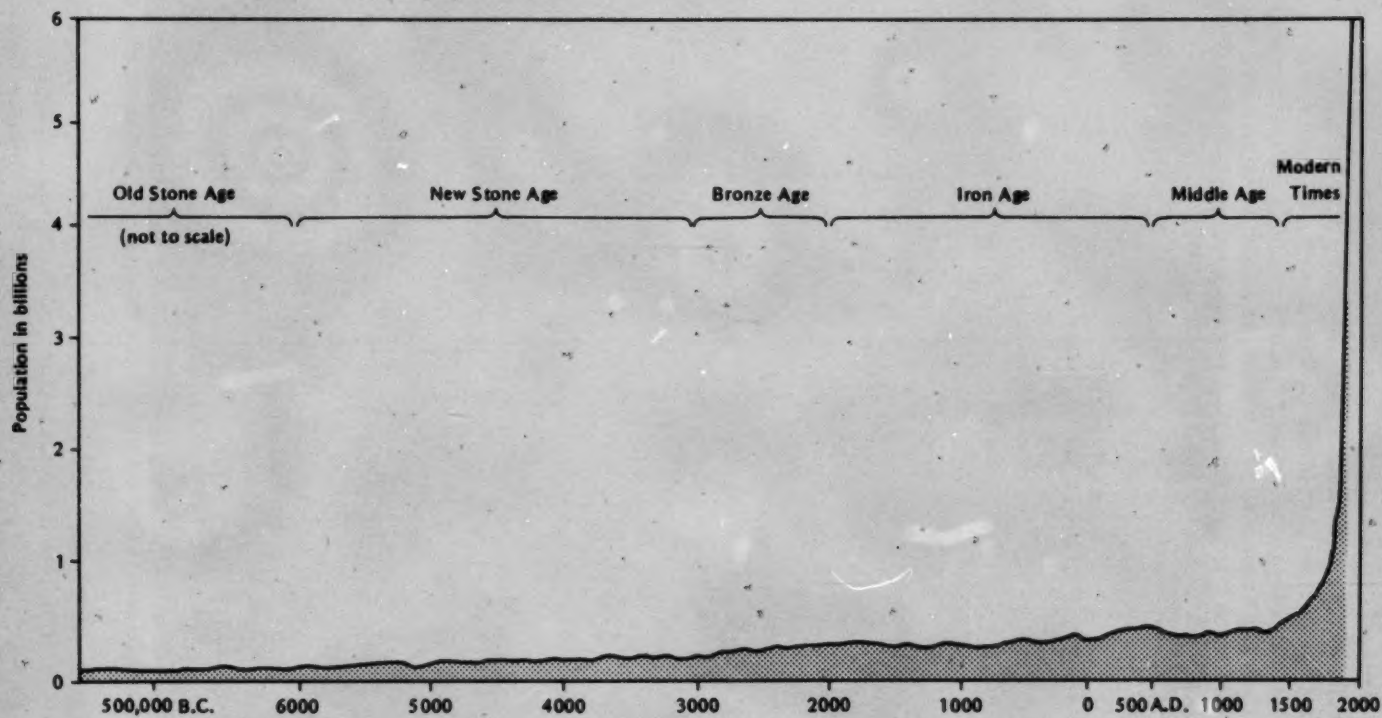
This estimate of the population growth rate of the Neolithic period is based on an evaluation of the length of the period and the probable world population at the end of the period. It assumes that at the onset of the Neolithic era, world population was very small. Of course, no one knows with certainty what world population was at that time. It is possible that there were as many people before the agricultural revolution as after it, and that population did not grow at all during the period.

It is clear, however, that throughout tens of thousands of years of human existence long-term population growth was negligible (see Figure 3-2). If growth was not the norm, where is the population pressure that drives Boserup's model? If, on the other hand, population growth did tend to occur at least periodically, why were people not motivated to replace hunting and gathering with shifting agriculture at a much earlier point in their existence? We have already indicated that population stability probably could have occurred only if there existed environmental and cultural controls on growth. Since stability did persist for long periods of time, people must have successfully manipulated their numbers by adopting behavioral norms that influenced the frequency of births, deaths, or both.

Why did the size of human population remain so stable for such a long time? What were the patterns of fertility and mortality that maintained such a situation? Acsadi and Nemeskery have undertaken an extensive study of prehistoric mortality. Careful analysis of the age and sex characteristics of ancient skeletal remains has permitted them to reach

⁴ Quoted by Clark (1968:130).

FIGURE 3-2. Growth of the human population



what appear to be sound conclusions concerning the probable age- and sex-specific rates of mortality in both preagricultural and postagricultural societies. Their findings concerning the mortality conditions typical of those two eras are summarized below (Acsadi and Nemeskery, 1970):

PREAGRICULTURAL SOCIETIES (PALEOLITHIC ERA)

1. Life expectancy approximately 20 years.
2. Half of all persons died by age 15.
3. Very high rates of infant mortality.
4. Female mortality higher than male mortality at all ages.
5. Major causes of death: accident, injury, combat wounds; thus little fluctuation in mortality rates from year to year.

POSTAGRICULTURAL SOCIETIES (NEOLITHIC ERA TO MIDDLE AGES)

1. Life expectancy 25 to 30 years.
2. Half of all persons died by ages 15–20.
3. Very high rates of infant mortality.
4. Female mortality higher than male mortality at all ages.
5. Major causes of death: illness, plague, combat wounds; thus periodic fluctuations in mortality rates.

Although there were differences in the mortality characteristics of the two eras, the eras were basically similar in that mortality was high, young people were as likely to die as older people, and women generally faced worse mortality conditions than men.

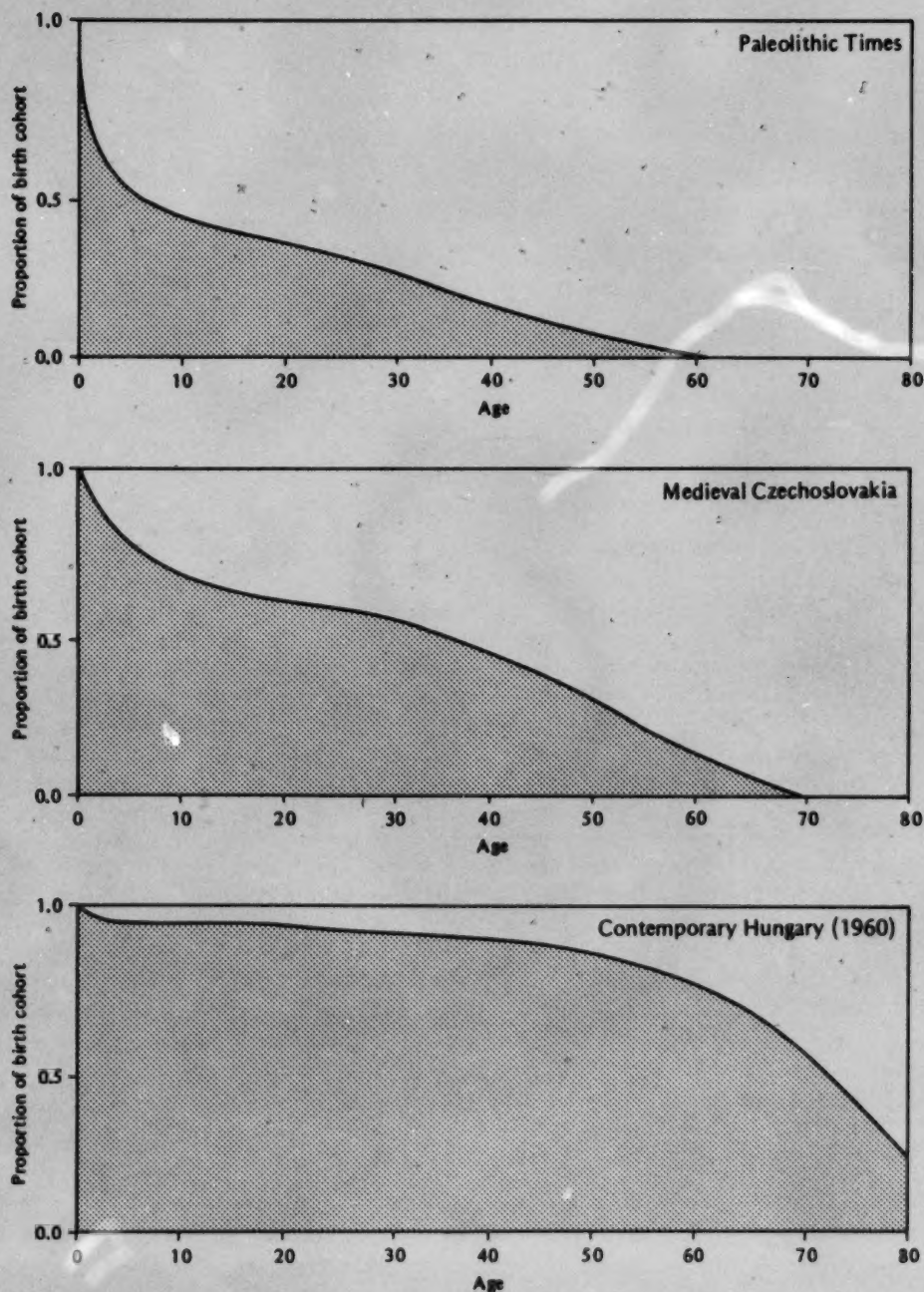
Figure 3-3 summarizes the estimated age-specific mortality conditions before and after the agricultural revolution and compares them with the conditions in a typical "modern" population. The agricultural revolution corresponds to a far less significant shift in pattern of human mortality than does the industrial revolution with its concomitant hygienic and medical discoveries. When these three successive patterns of mortality are considered in the context of world population growth, one has to conclude that throughout most of human existence mortality has been the prime determinant of population growth (see, for example, Durand, 1972).

Pre-Columbian societies must have had very high fertility rates in order to have avoided extinction. Estimates vary, but it is generally agreed that fertility must have approached the biological maximum. Bogue (1969:53–54) emphasizes this point:

During the many thousands of years of man's existence on the earth before the beginning of civilization, the population problem facing most communities was that of survival—to offset successfully the terrible attrition of death on their numbers. . . . It has been reported . . . that if man has lived on the earth for 100,000 years as supposed, the entire population of the world today can be the offspring of a mere half dozen couples reproducing in such a way as to grow at the slight rate of 0.002 percent per year⁵ (1/100 of today's rate). We are forced, therefore, to conclude that the human race has been required by circumstances of high mortality to reproduce at near biological capacity and that a whole system of fertility-promoting practices has evolved as an integral part of every culture.

⁵ Editor's note: Bogue was in error. The U.N. figure on which his calculation was based is 20 per 100,000 per year, or 0.02 percent (United Nations, 1953:5).

FIGURE 3-3. Proportion of birth cohorts surviving to specific ages in preagricultural, postagricultural, and modern times



Source: Adapted from Acsadi and Nemeskery (1970:170-200).

But now arises the question of what is the maximum rate of human reproduction. It has been estimated that a healthy woman who survives through the childbearing years can produce about 20 babies, excluding multiple births (Bates, 1962:82-83). It is unlikely that such a high figure could be attained generally; more plausible as an average figure is the 12 to 14 offspring typical of members of the most reproductive female group in the modern world, the Hutterite women of North America (Eaton and Mayer, 1968). Because the Hutterites have extremely high marital fertility and marriage is virtually universal, their reproductive behavior can be taken as approximating the biological maximum.

Let us assume, then, that 14 children represent complete success for women intent on maximum procreation. If we consider that under the mortality conditions prevailing in Paleolithic times half the population was dead by age 15, it follows that almost half the females never bore any children. Consequently, for the group as a whole it is unlikely that females had more than seven offspring on the average. Since female mortality continued to be high throughout the childbearing years, the average number of births must have been significantly less than seven. But Durand (1972) has pointed out that with a 20-year life expectancy each female must produce six children just to replace the population from one generation to the next.

In Paleolithic times humans seem to have overcome staggering odds just to have managed survival. Even after the agricultural revolution, mortality was so high that survival was only slightly less difficult.

This discussion of mortality and fertility in early times justifies Durand's assertion (1972:374):

... it is not necessary to suppose as a general rule in human societies of the past that, if population failed to make a large growth over long periods of time, this was due necessarily to the imposition of severe restrictions on reproductive power—whether by infanticide, abortion, or other means of control. One can envisage that population might often have failed to make natural growth even with minimal restrictions on procreation, in view of the conditions of mortality. On the other hand, when and where an expansion of population took place, we do not necessarily have to view it as a result of the relaxation of controls on fertility. . . .

Since mortality—not fertility—was the prime mechanism of population change, the population pressure that Boserup claims motivated people to discover and adopt higher levels of agricultural intensification must have been the result of declining death rates. But mortality is a consequence of prevailing environmental and socioeconomic conditions. What reason is there to believe that those conditions would have changed before intensification took place? It is more likely that, after intensification, improved living conditions permitted population growth; the limiting factor may not have been food supply. Furthermore, if this growth led to pressure on food resources, it is likely that the immediate result would be increased mortality and a restoration of population balance.

EARLY SOCIETIES AND POPULATION CONTROL

Even if Boserup is right in assuming that early populations on occasion had a tendency to outstrip the carrying capacity of the land, it does not automatically follow that agricultural intensification was the only, or even the best, solution to the problem.

Many would argue that the problem was not perceived; that as population growth occurred, early populations were required to make that imperceptibly small extra effort necessary to yield the required additional produce. There are a number of flaws in this position. First, it is hard to believe that any group entirely dependent on agriculture would

have been unaware that it was making the sorts of adjustments involved in shifting from long fallow to short, from fallow to annual cropping, or from annual cropping to multi-cropping. Second, considering the lack of control over mortality in those times, it seems probable that an ecosystem under stress would tend to exact a higher death toll. This seems particularly likely since almost all agricultural systems are subject to natural hazards of varying degrees of intensity. The inevitable "bad year" would go a long way toward restoring population balance. Third, it is improbable that early religious and moral codes protected human lives as strongly as do our modern ones. Death due to infanticide, suicide (e.g., among nonproductive, aged Eskimos), and neglect of dependents may have increased during hard times.

If early societies were aware of the problem of overpopulation, there are numerous ways in which they could have exercised control over their growth, which could have proceeded only at a slow rate. In some instances, that control might have been unconscious; in others, the individuals would have realized that they were limiting their numbers.

Katz (1972) has outlined some biological factors that can depress fertility, most of which are sensitive to environmental conditions:

1. Body size is directly related to both the timing of onset of pubescence and to nutrition. In earlier times if nutrition was generally poor the ability to reproduce may not have been achieved until a somewhat later age than is generally the case today.
2. High body temperature in the area of the male sex organs can cause sterility. This could have been a problem among groups in which the men wore restrictive clothing.
3. Very high altitudes impair fertility.
4. There are stress effects associated with population density that may cause a decline in fertility. This phenomenon has been documented for human populations, but only under conditions of very high density.
5. Shifts in dark-light cycles can cause a decline in fertility. Katz presents statistical evidence to this effect for Eskimos residing on the North Slope of the Brooks Range.
6. Breastfeeding may inhibit a woman's return to normal fecundity after childbirth.

None of these biological influences on fertility (except the fourth) could reasonably be expected to show a systematic variation relevant to the issues under discussion. They do represent a different perspective, however, that rarely occurs to economists and anthropologists. There may be biological changes associated with different levels of population density and different degrees of agricultural intensification. It is conceivable, for instance, that high population density or high levels of cultural stress lead to greater sexual promiscuity. If so, some evidence suggests that female promiscuity decreases fertility (Greenfield, 1968).

Such cultural mechanisms as territoriality and war may also serve to check population growth without people's being aware of it. Territorial transgressions have probably been a frequent cause of war, and war undoubtedly affects population growth. (See, for example, Dubos, 1969:22; Birdsell, 1958. Birdsell suggests a way that the geometry of territoriality could have stabilized population size by regulating the marriage rates.) As a device for controlling population size, war is related to our concern over density in premodern populations. As density increased, it is likely that the frequency and intensity of war escalated.

Then population pressure would have been relieved by territorial expansion (in the case of victory) or population decline (in the case of defeat).

In addition to involuntary population control mechanisms, it is possible that at the individual, familial, or societal level early people were aware of the implications of population growth and deliberately attempted to limit it. Kingsley Davis (1963:362) suggests that a society will usually have a demographic response to changed mortality conditions: "... faced with a persistent high rate of natural increase resulting from past success in controlling mortality, families tend to use every demographic means possible to maximize their new opportunities and to avoid relative loss of status. . . ." He confines his thesis to modern demographic history, documenting the use of migration, delayed marriage, and abortion to cope with undesired population growth. He does not explain why he has not applied his behavioral theory to premodern societies, but lack of hard data is the probable reason. It seems reasonable to assume that such a demographic response would not be unique to the last few centuries of human existence.

Davis and Blake (1956) identified 11 ways that culture can affect fertility, classifying these "intermediate" variables into three categories: (1) factors affecting exposure to intercourse, (2) factors governing exposure to conception, and (3) factors affecting gestation and successful parturition. The authors observed that all populations shape their fertility patterns by positively or negatively employing these intermediate variables. It is likely that at least one or two of these variables prevented fertility from reaching a biological maximum in virtually all social groups of the past. Davis and Blake identify voluntary abstinence and involuntary foetal mortality as typically inhibiting fertility in preindustrial societies. Other variables that primitive groups could have manipulated to control population size are post-widowhood celibacy, the amount of reproductive period spent between unstable unions, and voluntary foetal mortality (abortion).

A number of studies indicate that early societies had both the desire and the means to limit their numbers. Opler (1956) has documented a concern with controlling fertility among the Jicarilla Apaches. He suggests that they practiced *coitus interruptus* and abortion to avoid having unwanted children. Sussman (1972) has developed a convincing argument concerning the need for Paleolithic peoples to insure group mobility by adequately spacing births. He refers to a similar need documented among bands of gorillas and concludes that before human existence became sedentary a mother would have been able to move with the group only if she had not more than one infant to care for. Child spacing could have been achieved by placing a taboo on intercourse as long as a mother was nursing a child, or by killing any child born before the mother had stopped nursing a previous offspring.

One of the more comprehensive statements on population control in primitive groups has been made by Mary Douglas (1966; see also Himes, 1963). Douglas believes that the "Davisian" theory is appropriate to primate societies, and she refers to fertility limitation practices used by four quite different groups to support her position: (1) female infanticide among the Netsilik Eskimos (hunters); (2) late marriage and male infanticide among Kenyan camel herders (nomads); (3) abortion, contraception, infanticide, and suicide migration in Tikiopia (agriculturalists); and (4) limited marriage among the Nambudiri Brahmins of southern India (wealthy, elite agriculturalists).

There is thus considerable evidence that early societies had both the desire and the means to limit unwanted population growth. It is important to remember that mortality conditions were such that population growth could only have occurred slowly. That being

so, it would take only a weak control mechanism to return the population to stability. Such mechanisms were available in abundance, obviating the need to resort to agricultural intensification.

Particular reference should be made to the practice of infanticide. This very effective means of population control was apparently used by a number of primitive groups. It might be revealing to consider just how effective infanticide could be in limiting population growth. Consider a hypothetical society that practices female infanticide. If that group has a population of 1,000 and exhibits typically high mortality and fertility, it would perhaps experience about 45 deaths and 50 births each year, yielding an annual growth rate of 0.5 percent. Yet the group would have to kill an average of only 2.5 female infants per year to bring about population decline and eventual extinction. Since most Paleolithic groups probably had populations closer to 100 than 1,000, they could have accomplished the same end by eliminating .25 infants each year, or one every four years. In societies that practiced infanticide it is hard to believe that population pressure would ever have been a problem.

MIGRATION

Boserup assumes that a group will intensify its agricultural practices when its growing population has no opportunity for territorial expansion. This means that there can be no out-migration. But is this a logical assumption? There seem to be only two situations that could confine a population to a given territory: (1) environmental barriers such as mountains, oceans, or deserts that create insularity, and (2) powerful neighbors who would resist incursions on their territory. But environmental barriers are not likely to restrict a population. The group crossed the barrier in the process of in-migrating; there is no reason why they could not recross it to get out. If, on the other hand, powerful neighbors are confining the group, then consideration must be given to the fact that a growing population would eventually mean a dominant population size and the ability to displace the neighbors. Thus the instances in which out-migration was impossible must have been very rare.

THE QUESTION OF INTENSIFICATION

It is ironic that professional critics are rarely able to engage successfully in that very activity that draws their criticism. A sense of inadequacy arises whenever one attempts to create a viable alternative to Boserup's powerfully logical explanation of why primitive societies would have been moved to intensify their agricultural systems. Yet such an achievement would be the most constructive criticism of Boserup's work.

If not to solve the problem of population pressure, what reason would early people have had to undertake the additional effort necessitated by a more intensive form of agriculture? Perhaps there was a desire to achieve greater security from natural dangers and other groups. Perhaps their naturally gregarious nature made them willing to pay the economic price of higher population density. Possibly environmental controls were somehow decisive. Maybe centralized polity or social stratification preceded intensification and encouraged it. At any rate, modern societies are finally beginning to realize that the world is bewilderingly complex and historical events rarely can be explained satisfactorily by a single cause.

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4

Human and Social Resource Analysis in Population Geography

The interrelationship between population, resources, and technology has been a long-standing concern for population geography. In general, geography curricula in Asia and the Pacific stress this concern to a greater extent than do those in Europe or North America, in part because of their academic traditions, but also because this focus is much more than an academic exercise for the developing world. This section is a departure (indeed, a radical departure) from the conventional approach, for it stresses human beings as the basic resource and human ingenuity as the ultimate technology.

POPULATION-RESOURCE ANALYSIS

Concluding the first report for the Club of Rome's project on the Predicament of Mankind, Meadows et al. (1972:23) state:

If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years.

Their conclusion dramatically reveals one of the central concerns of population studies: the fear that the world will not be able to provide adequately for its inhabitants in the future. It is this spectre of mass poverty that gives the study of population its justification and sense of urgency. Without population-resource analysis the study of population would become merely a descriptive exercise, study undertaken for study's sake.

Even a cursory review of the literature on population-resource studies reveals one outstanding feature: the overwhelming importance given in the study of population to both renewable and nonrenewable natural resources (see, for example, Committee on Resources and Man, 1969; Meadows et al., 1972; Ridker, 1972), and the relative neglect of human and social resources in the population-resource equation. The Club of Rome Report will serve to illustrate this emphasis (Meadows et al., 1972). It identifies two ingredients needed to sustain world economic and population growth, the first being physical necessities such as food, raw materials, and fuels, and the second consisting of social necessities such as peace, social stability, education, and steady technological progress. While acknowledging the importance of physical resources, the report asserts that they are not sufficient conditions for growth because growth depends primarily on the social resources. Yet the authors conclude that because social resources are much more difficult to assess than physical factors, their world model is not sufficiently developed to deal with them explicitly. By ignoring, or holding constant at present-day levels, the human resource element in the population-resource equation the conclusions drawn are inevitable. Natural

resources, which are culturally defined, are in effect limited in quantity to known levels of technology. Given the fact that population numbers and demand are steadily increasing, an assumption of constant human resources leads to conclusions like the one arrived at by the Club of Rome.

This section argues that the inherent capabilities of people to foresee and adjust to resource shortages must be taken into consideration because "... to an ever increasing extent the resources of civilized man are not natural resources but human inventiveness, experience and knowledge" (Trewartha, 1953). Direct measures of human inventiveness, experience, and knowledge are difficult to develop, but such surrogate measures as the amount of scientific work, the number of inventions, or the time lapse between postulation and proof all indicate that human knowledge is increasing at an exponential rate (Bell, 1968). Because natural resources for the most part merely reflect the existing level of technology, there being a positive correlation between level of technology and the range and size of the natural resource base, it is critical to population-resource analysis to take human resources into account.

In studying the relationship between environment and poverty, Morrill and Wohlenberg (1971) concluded: "No clear-cut or significant relationships were found between available measures of resource endowment and incidence of poverty. . . . The growth and prosperity of regional economies are more and more a function of industries and services that are further and further removed from raw materials. . . . we have concluded, frankly, that the root of poverty lies in the inability of society to allocate power equitably [to persons and regions], and of the economy to allocate rewards justly."

The study of social, economic, and political factors is just as crucial as the study of physical factors if a more complete understanding of the relationship between population and resources is to be achieved.

Finally, there is the question of at what scale population-resource studies should be conducted. Most studies take a long-term global point of view (for an exception, however, see Odum, 1970). We are of the opinion that at the undergraduate level local and national analysis should be given prominence; and because of the difficulties of making reliable long-term predictions, analysis should be kept to the past, especially to the present, and to the near future.

HUMAN AND SOCIAL RESOURCES

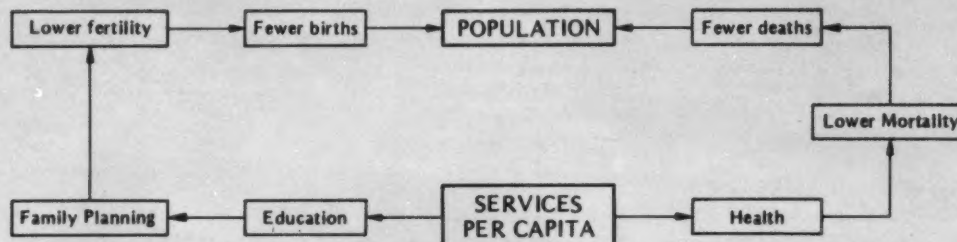
Though often used interchangeably, the terms *human* and *social* resources can, and should, be differentiated. A human resource is defined here as those characteristics an individual or group of individuals possesses such as level of intelligence, ingenuity, and culture (religion, philosophy), whereas a social resource is an institution established by a person or group of persons that either serves human needs (e.g., medical services) or human advancement (e.g., educational systems). Social resources therefore provide the means by which the quality of human resources is improved. For example, a human resource created by an educational system (social resource) is intellectual achievement. People are therefore the ultimate resource. They create social resources not only to serve them, but also to help them improve themselves so that they can make better use of their environment.

The extreme difficulty of directly measuring human resources necessitates the substitution of social resources as surrogate measures of human resource development. It is possible to identify two categories of social resources (Coleman, 1971):

1. *Social resources as ends in themselves.* These are analogous to the economist's concept of consumer goods and are primarily used to meet present demands (for example, recreational services).
2. *Social resources as a means to ends.* These are analogous to the economist's concept of production goods and may best be regarded as investments in the future. The returns on these resources are not immediate but often far outweigh the initial investment outlay. Education services are a good example of this second category.

A primary objective of population-resource analysis is to determine the availability of social resources to the population in the form of a ratio (the number of physicians or teachers, for example, per hundred or thousand persons), the assumption being that the larger the ratio of service to population, the better the situation. Optimizing criteria established by international organizations or the ratios reached by the advanced nations may be adopted as standards against which other areas are measured. Even more useful than ratios calculated from aggregate populations are ratios calculated for different socioeconomic and ethnic groups, rural and urban populations, and other population subgroups. Analysis of these ratios over time will indicate whether or not desired rates of improvement have been achieved.

Social resources may also be related to such common demographic processes as fertility and mortality, as in the following diagram (adapted from Meadows et al., 1972):



Of critical importance to the geographer is whether population-social (and human) resource analysis has an important place in population geography. Browning (1974) has stated that "a topic—no matter how interesting, topical or relevant—should not automatically be embraced as geography." To measure the geographical content of a topic the following principle is suggested: "... the collection, analysis, and presentation of data relating to spatial distributions and attendant regional patterns become meaningful in population geography only when carried forward a step to include inquiry into the processes which influence, indeed create, particular spatial distributions" (Demko, Rose, Schnell, 1970). The critical question is therefore why spatial distributions are structured as they are (Abler et al., 1971).

Concern with the availability of resources can be shown to be compatible with the geographer's interest in the distribution of these resources. Indeed, it can be shown that the availability of social resources for consumption depends on their initial distribution. By studying the maldistribution of resources and drawing up recommendations to effect a more equitable distribution, geographers make one of their most important contributions to the study of population.

THE CONCEPT OF TERRITORIAL JUSTICE

Of growing interest in academia is the concept of social justice. This section on population and human resources seems an appropriate place to introduce the concept, and especially its spatial parallel, territorial justice.

The concept of social justice may best be summarized by the principle "to each according to his need." Three criteria for measuring social justice have been suggested (Harvey, 1973):

1. *Need.* Individuals have a right to equal benefits.
2. *Contribution to the common good.* Individuals whose activities benefit most people have a higher claim than do those whose activities benefit few people.
3. *Merit.* These claims should be based on the degree of difficulty to be overcome in contributing to production.

The principle of social justice has been formulated in realization that such social resources as housing, medical care, education, social and environmental services, recreational opportunities, neighborhood amenities, and transport facilities are not equally available to all, and that this inequitable availability is a persistent problem. The usual method of measuring the degree of social justice is to establish certain minimum quantities and qualities for these services, which are equated with needs, and to calculate the difference between the expectations of the people and the actual services received as a measure of relative deprivation or social injustice (Harvey, 1973).

The causes of social injustice are many. Two major causes are discrimination based on personal or economic characteristics, and deficits of economic, political, and personal resources. Both severely restrict an individual or group's freedom of action (Coleman, 1971; Morrill and Wohlenberg, 1971).

The concept of social justice is of particular interest to the population-resource analyst because it suggests that the problem results not necessarily only from a shortage of resources, but also from differing capabilities for using available resources. One persistent and striking feature of the problem is that the more socially and economically depressed segments of a community, which are in most need of social services to improve their lot, are least able to attract these services because of their low purchasing power. As a consequence they remain deprived communities.

Geographers have traditionally been interested in locational efficiency, where distances and transportation costs are the factors that must be minimized. Because least-cost locational analysis uses mathematical models, it has been credited with reducing human bias and resulting in a more "scientifically" precise location. These locational models, however, are based on critical assumptions of population homogeneity and rationality, examples of which are difficult to find in reality. According to Symons (1971), "... distributional equality represents the scientific geographer's nemesis. Problems posed by perceptual distortions, inability to make rational decisions, differences in fluctuating personal and social utility functions, are areas in which the scientific community has made little progress." Morrill (1973) has added: "the use of seemingly value-free mathematical models ... involve[s] the risk of significant discrimination against some people or areas." An example is the Law of Diminishing Returns which predicts that after a certain level of investment, the diffusion of additional investment to deficit areas is necessary to maintain maximal profit margins. This is often not the case; instead, a satisfier principle operates such that so long

as there is a profit margin, spatial immobility is predictable. A study of the changing location of physicians (Lankford, 1971) found that, in order to maximize their expected income, physicians tended to locate in the larger cities, and in particular the wealthy suburbs, the net result being "... an increase in the number of physicians where the physician-per capita ratio is already relatively high, while the problem of the generally low level of health facilities for the poor is sharply aggravated."

The conclusion that "... efficient distributions of facilities do not necessarily correlate with equitable distributions" (Symons, 1971) has led to a debate about the relative priority of spatial equity and spatial efficiency in recent years. From this debate has emerged the concept of territorial justice, which in summary is "to each area according to the needs of the population of that area" (Davies, 1968).

The concept of territorial justice is embodied in the second principle of Morrill's Declaration of Conscience and Statement of Purpose (1973):

The spatial arrangement of human activities must reflect the needs and desires of those occupying areas and society as a whole, not the narrow goals of economic efficiency, nor the interests of just property owners and investors. ... Spatial inequality in income, services and justice must be alleviated.

The principles of social justice when applied to geography require therefore that the spatial organization and pattern of regional investment in social, and ultimately human, resources be such that they fulfill the needs of all sections of the population. Any difference between the needs and actual allocations provides an initial evaluation of the degree of territorial injustice in the existing system. According to Harvey (1973), the ultimate objective of geographers should be to develop a theory of spatial organization based on territorial distributive justice—that is, "... to design a form of spatial organization which maximizes the prospects of the people in the least fortunate region."

The relationship between social and territorial justice is best summarized by Davies (1968) as follows: "Territorial justice is a necessary condition, but not of course a sufficient condition, for achieving social justice."

At the undergraduate level of population-resource analysis it is sufficient (a) to develop and map some simple indices of territorial justice; (b) to analyze the resulting spatial pattern and speculate on the processes that have created this pattern; and (c) to analyze geographically-oriented solutions to the observed problems and relate these to the solutions proposed by other social scientists.

SOCIAL RESOURCE INDICATORS

Since our primary concern is measuring the availability of social amenities to the population, simple per capita indices may be calculated. Some commonly used indicators are infant mortality rates, physicians per capita, hospital beds per capita, levels of education achieved, the proportion of houses above or below a certain quality level, recreation facilities per capita, proportion of households with poor diets, and literacy rates (Smith, 1973). Many more such surrogate measures of social well-being may be found or calculated from officially published data sources. A useful class exercise would be to ask students to list population-social resource ratios they believe to be important, look for the relevant statistics, and calculate comparative indices.

Several shortcomings of the simple calculation of the ratios as described above should

be noted. Different people have different needs, and calculation of ratios using gross population figures can be misleading. A young population, for example, has greater need for educational services than an older population. The availability of social services often varies markedly by ethnic group, a fact which will only emerge if an ethnic analysis is attempted. The refinement of these measures by incorporating such common demographic variables as age, sex, and race is recommended. The ratios may be calculated for administrative units (the smaller the unit, the more accurate the analysis), grouped into classes and mapped.

Several simple but more sophisticated ways of treating these ratios may be attempted. One is the calculation of location quotients. Several over-all measures of the equality of spatial distribution have been suggested. Davies (1968) notes that "the statistical definition of territorial justice is a high correlation between indices of resource-use, or standards of provision, an index measuring the relative needs of an area's population for the service, the relative inequality of the standards indices being the same as that of the need index." He suggests two indices: (1) the coefficient of variation, which measures the relative extent of the variation of the observations about their mean, the effect of the number of observations being discounted:

$$\left[\frac{\frac{\sqrt{\Sigma(x-\bar{x})^2}}{N}}{N} \right] 100$$

and (2) the correlation coefficient, which measures the extent to which the positive deviations of readings from their mean in one variable are associated either with positive or negative deviations in the other:

$$\frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{[\Sigma(x-\bar{x})^2][\Sigma(y-\bar{y})^2]}}$$

The larger the coefficient of variation and the lower the correlation coefficient, the more unequal the distribution.

Other well-known measures include the coefficient of localization and Gini coefficient. The drawing of a Lorenz curve will show graphically the deviation from equality.

A simple measure of spatial inequality increasingly used by geographers is the Z , or standard score, statistic (see Lowry, 1970; Smith, 1973).

$$\text{Standard score } Z = \frac{x-\bar{x}}{s}$$

where x is the regions statistic,

$\bar{x}$ the mean for all the regions, or some optimum statistic,

s the standard deviation of the distribution.

The Z score of a region is therefore an indicator of the deviation of that region from the national mean measured by standard deviations. The Z score therefore gives a measure of regional variability and hence a measure of territorial injustice.

Smith (1973) presents a simple standard score additive model, which enables one to compare social indicators directly and develop an overall index of social well-being. Calculating the Z score transforms the original data linearly such that their mean becomes zero and their standard deviation unity. Expressed as Z scores, different indicators can be

directly compared, and a composite social indicator (CSI) calculated by adding up the regions' Z scores for respective indicators.

$$CSI = \sum \frac{x - \bar{x}}{s}$$

The spatial analysis of the CSI allows conclusions to be drawn with respect to territorial justice.

More advanced mathematical treatment of standard scores such as principal components and factor analysis are possible, but these are likely to be beyond the scope of an undergraduate course.

MEANS OF ACHIEVING SOCIAL JUSTICE

A population geography course may not seem to be the place to discuss ways and means of overcoming social injustice, but, as Peach (1973) has noted, "It is frustrating . . . to read so much research which stops short of any recommendations about how to change the observed situations." Indeed Harvey (1972) has gone so far as to say:

We have enough information already and it is a waste of energy and resources to spend our time on such work. In fact, mapping even more evidence of man's patent inhumanity to man is counter-revolutionary in the sense that it allows the bleeding-heart liberal to pretend he is contributing to a solution when he in fact is not.

Two alternatives present themselves: If one agrees with Harvey, then a noisy demonstration outside city-hall should be organized as a tutorial exercise in revolutionary geography. If one does not, then a more somber, if somewhat less exciting, discussion of how to eliminate these injustices should be initiated to round out this section on population and human resources. It must be noted that geographically-oriented solutions are "only a means to reorganize the economy in a way to bring about more regional equity. . . . There still remain the structural problems of discrimination, differential power, income distribution and the matching of labor supply and demand" (Morrill and Wohlenberg, 1971). Social, economic, and political solutions must therefore not be neglected because in many instances these structural solutions are a prerequisite to reorganization of the spatial economy, thus bringing about greater regional equity in the distribution of social resources.

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5

Migration and Mobility

The movement of people is both a cause and a consequence of the growth and distribution of population. In some areas of the world (especially cities), migration, rather than natural increase, is the primary cause of rapid population growth. Moreover, the movement of people consumes a major share of the earth's energy resources. Despite the importance of the topic, migration has tended to be the forgotten child of demography. Its neglect results in part from the paucity of information available about migration. Most countries have established registry systems for the collection of data about vital events, but migration registries are uncommon. Moreover, even where information on movement is recorded, it tends to be recorded infrequently, or on a scale that permits the formulation of only the most general findings.

Although migration and mobility studies have tended to be central to population geography, they have been a peripheral concern of demography. This is due in part to geography's long-standing concern with movement in general, and probably in part to the field tradition of geography, which makes geographers less dependent upon data collected and maintained by others. The following section presents an overview of geographers' approach to the study of migration. Although the geographic and demographic approaches to migration have become more similar in recent years, there still exist important differences in emphasis.

MIGRATION: THE DECISION TO MOVE

Migration, conventionally defined as a permanent shift of residence across predefined boundaries, may be considered to be a human response to intolerable economic, social, and demographic forces in the environment. Presumably, migration is not the only response to these forces if alternatives are available.

There tends to be an identification of the self with the locale in which one has resided for a prolonged time, and some emotional strain is involved in leaving this locale and family, friends, and colleagues for a strange new environment (Bogue, 1969:753). Some people may choose lower levels of living, at least until pressures become severe, before leaving a home environment. Indeed, it appears that migration is chosen reluctantly by most people, particularly in areas where family ties and community bonds are keenly felt (Kosinski and Prothero, 1970:266).

Migration may be viewed as an outcome of the mismatching between individuals and their habitat. The relative impact of environmental stress, however, depends very much on

individual attributes, such as "the cumulative physical, emotional and social experiences of the individual combined with his endowment" (Wolpert, 1966:93). Kinship ties and community bonds apparently alleviate the environmental stress and tend to strengthen an individual's resistance to stress. Under certain circumstances, people can be considered to be sedentary as long as their needs are satisfied. The mismatching between people and their environment, which normally results in unsatisfied needs, might cause them to move.

STAGES IN THE DECISION-MAKING PROCESS

The decision to move or to stay is normally an outcome of a complicated process involving physical and psychological aspects of behavior. A simplification of the process, however, results in five major stages, as follows:

1. A problem arises.
2. The individual affected becomes aware that the environment does not give sufficient satisfaction.
3. He or she makes an inventory of possible solutions: those that entail moving and those that do not.
4. He or she compares the alternatives.
5. The person makes a decision to move or stay.

The whole process is portrayed graphically in Figure 5-1. The first stage of this process has been discussed in the preceding paragraphs. The subsequent stages will be discussed briefly.

The second stage. The mismatching between a person and the environment might or might not be perceived by the individual concerned. A slight environmental stress, for example, might go unnoticed. But an environmental hazard, such as famine or drought, is likely to be perceived by everyone concerned.

The intensity of the stress, however, is not the only determinant of whether or not a stress is perceived. Even a prolonged, terrible environmental stress may go unnoticed if people are already adjusted to the stressful situation. In such a case, the people do not recognize the existence of a problem, for they have consciously or unconsciously altered their view of what constitutes a problem. As long as they perceive the situation in that way, there is no problem to be solved and they feel no dissatisfaction.

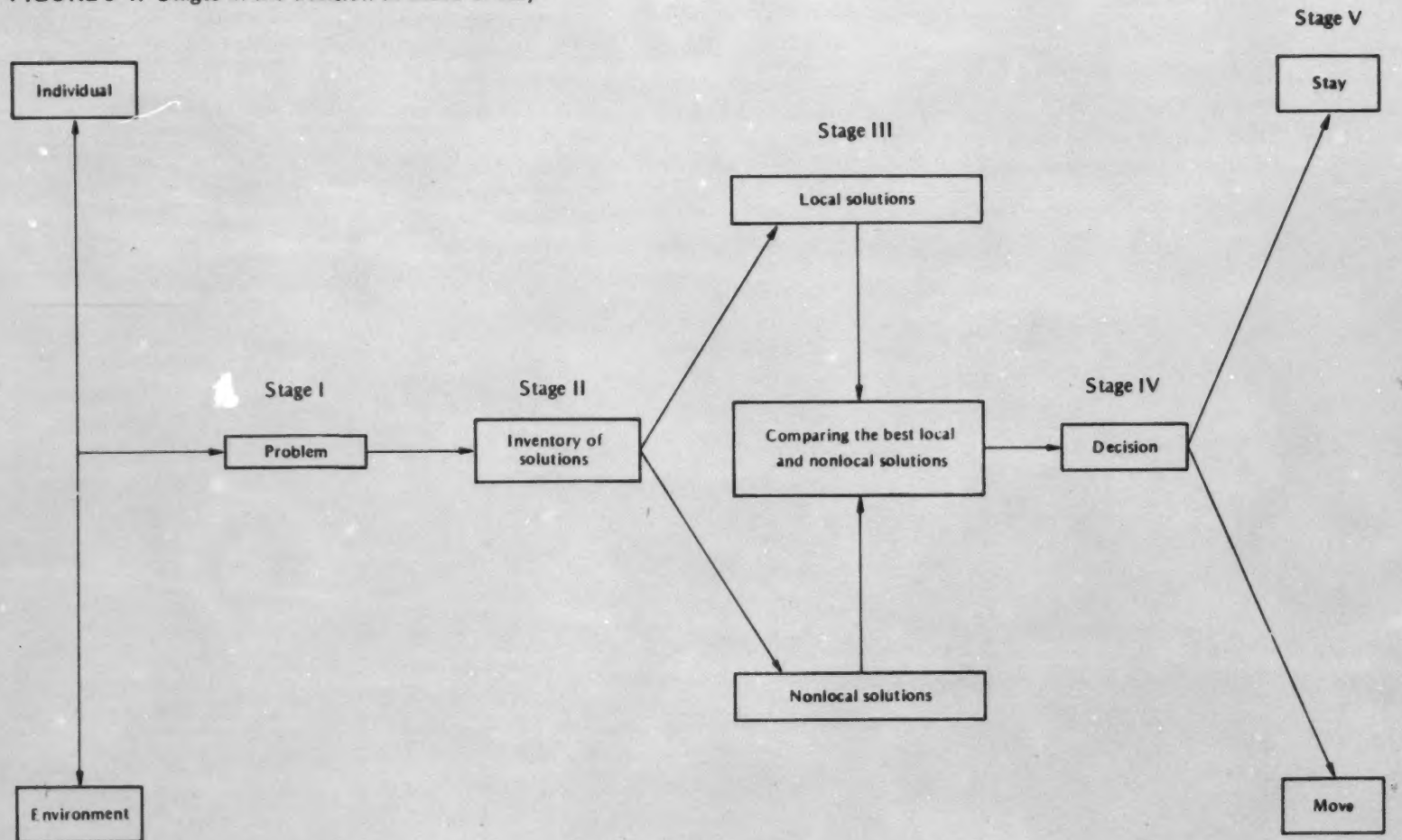
Environmental stress, regardless of its intensity, becomes a problem only if it is perceived by the people affected by it and if they try to avoid or to overcome the problem. This attitude is called *avoidance* (Lee, 1966:87) of the stressful situation, just as the opposite is called *acceptance*.

A person's awareness of the existing problem—and attempts to avoid the problem—are normally followed by the subsequent step of taking an inventory of possible solutions.

The third stage. The inventory of possible solutions initiates the *period of germination* (Taylow, 1969:124)—that is, the period of collecting information, analyzing it, and comparing the results—which finally leads to a decision either to move elsewhere or to do something without moving to eliminate dissatisfaction.

The inventory of possible solutions is a complicated process, for different people may follow different strategies in making their inventories, and a myriad of alternatives may result. Two types of solution normally emerge in an individual's awareness, however: so-

FIGURE 5-1. Stages in the decision to move or stay



lutions that do not require moving from his or her present residence, and solutions by moving.

In this highly simplified model, the process of searching for the most appropriate local solution (that is, one that does not entail moving) contains three steps: collecting all possible alternatives, narrowing down the alternatives, arriving at one or more alternatives considered to be most appropriate. The process of searching for the most appropriate non-local (migratory) alternative is basically the same. The difference between the two is that in nonlocal solutions, there is a concern with alternative destinations and with the alternatives available within those destinations. Information about the potential destinations is obtained by direct and indirect contacts. The final outcome of the narrowing-down process is that one or more places containing one or more alternatives are considered to be the most preferable.

The fourth stage. This is the stage when the decision maker considers positive and negative aspects of the local and the nonlocal solutions, and his or her capability of undertaking each alternative solution. Barriers to migration, for example, are seriously considered. The outcome of this stage is two lists containing the costs and benefits of moving and staying.

The fifth stage. The decision to move or to stay is sometimes precipitated by an incident or an accumulation of incidents. Such incidents are called *triggers* or *precipitating factors* (Taylor, 1969:125). These factors are difficult to list because of their diversity. An incident, for example, might be a trigger for one individual but not for another. Precipitating factors are not always a precondition for a decision, because careful balancing of the positive and negative aspects of moving and staying may suffice.

VARIATIONS IN THE MODEL

The actual process of deciding to move or to stay obviously is not simple. Stages in the process are not as orderly as described here. An overlapping of stages is possible and some additional stages may exist in a given case. The decision-making process has been simplified for purposes of discussion to clarify its general pattern.

The degree of an individual's involvement in making a decision varies considerably from one person to another, and from one situation to another. For some people (for example, parents) the involvement is maximal; for others (e.g., children) the involvement may be minimal.

The basis upon which a decision to move or stay is made varies from one case to another. Two extreme types of decision have been identified (Taylor, 1969:126): the short-run, hedonistic decision, characterized by lack of future orientation and typically determined by current situational factors; and the purposive, rational decision, characterized by an objective analysis of the alternatives based on long-term occupational and life-style goals. There are many transitional types between the two extremes. These attitudinal aspects of decision making are not represented in the decision-making model shown in Figure 5-1.

Another important aspect of the decision-making process is the amount of time taken to arrive at a decision. Some persons require only a short period, whereas others may take a lifetime.

New dissatisfactions may arise at the place of origin after a decision to stay is made.

Even persons who have adjusted to a persistent stressful situation at the place of origin may develop new dissatisfaction; thus the process of deciding whether to move or to stay may be repeated. A similar process may occur at the new place of residence if a person becomes dissatisfied in his or her new environment. In such cases there is a possibility of return migration, a feature common to almost all migration streams.

DECISION-MAKING MODEL

Very succinctly defined, a model is a simplified structuring of reality that presents supposedly significant features or relationships in a generalized form. The most fundamental feature of models is that their construction has involved a highly selected attitude toward information, wherein not only noise but less important signals have been eliminated to enable one to perceive "something of the heart of things" (Chorley and Hagget, 1967: 22-23). Being capable of showing "something of the heart of things," a model is therefore a vital part of theory building, because the development of a theory normally springs from an understanding of the relationships between major variables.

In the previous section we were concerned with a reality—that is, the process of deciding whether to move or stay, an important aspect of migration studies. To clarify the basic pattern of that complicated process, we selected its major variables and reconstructed them into a logical, simplified pattern of relationships. The final product was a model in its simplest form (Figure 5-1).

Using the same set of the major variables, however, one can establish other kinds of models of the decision-making process. The following discussion will be concerned with a modification of the basic model, using the same variables and relationships, so as to demonstrate models of more practical value.

RELATIONSHIP OF MAJOR VARIABLES WITHIN PROCESS

In the previous section, the five variables involved in the decision-making process were characterized as *stages*. Those variables can also be viewed in *spatial* terms:

At the place of origin a problem arises; it is perceived by individuals living in that locale; they visualize some local solutions and consider one or more solutions to be optimal.

At the potential destinations some solutions are available; information from the potential destinations reaches the people at the place of origin through direct and indirect contacts, and one or more places offering solutions are considered to be best.

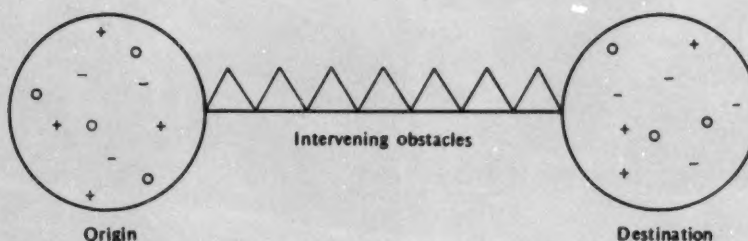
The people compare the benefits and shortcomings of the local and nonlocal solutions. The barriers of moving are seriously taken into consideration. They finally decide to move or to stay.

Thus both the place of origin and the potential destinations contain 'plus' and 'minus' factors. In the place of origin the 'minus' factors are problem-creating or stressful; the 'plus' factors offer alternative solutions. In the potential destinations the 'minus' factors do not offer any solution, but the 'plus' factors do. Barriers to migration may be considered as negative factors existing between the origin and the potential destinations. An individual must compare the positive and negative factors at the place of origin and the place of potential destinations, along with the negative factors of the barriers. Some models based on that conceptual framework are presented below.

Lee's migration model

Factors that enter into a decision to migrate, according to Lee (1966:47-57), are: those associated with the area of origin, those associated with the area of destination, intervening obstacles, and personal factors. The first three are represented schematically in Figure 5-2.

FIGURE 5-2. Lee's migration model



According to Lee's model, in every area there are factors that act to hold people within the area and attract people to it, and also other factors that tend to repel them. These are portrayed in Figure 5-2 as plus and minus signs. Other factors, to which people are essentially indifferent, are shown as zeros. Although migration may result from a comparison of factors at the origin and prospective destination, a simple calculus of plus and minus factors does not decide the outcome. The attraction to the move must be strong enough to overcome the natural inertia that always exists.

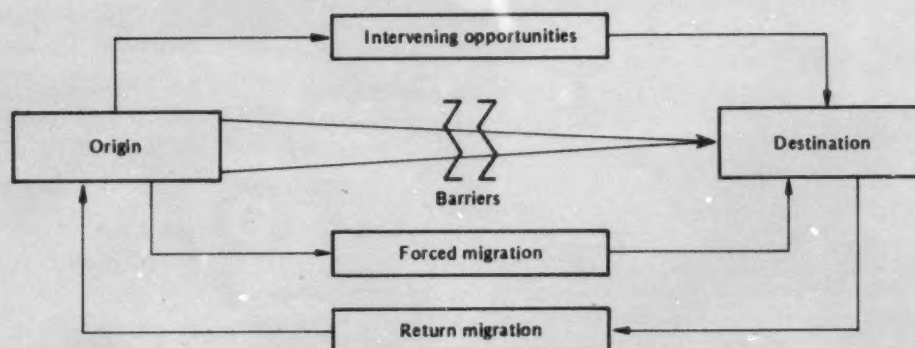
Furthermore, between two locations there exists a set of intervening obstacles of varying intensity. The most studied of these obstacles by geographers is distance. Personal sensitivities, intelligence, and awareness of conditions elsewhere enter into the evaluation of the situation at the origin; knowledge of the situation at the destination depends upon personal contacts or other sources of information.

Norris's migration model

The migration model developed by Norris (1972:294-301) can be shown as in Figure 5-3. The only difference between Lee's and Norris's models is the introduction of "intervening opportunities" by Norris. Intervening opportunities are not considered barriers to migration, because opportunities are part of the impetus to migrate, but they may deflect the migration from a predetermined destination.

According to Norris, the cost factor, or economic barrier, is primarily a function of the distance between the origin and the destination. The longer the distance, the more it costs to move a household. The other barrier is psychological in nature, and exists in various forms. One is the fear of new or unknown experiences that keeps some people from moving. Another is the inability of some people to break ties with friends and relatives. Attachment to a particular area is a third.

FIGURE 5-3. Norris's total migration model



Bogue (1969) has posited that migration is the result of "pushes" and "pulls," or attractions and repulsions, at both origin and prospective destination. In his view they are "balanced in the context of relative effort or cost of overcoming the obstacles that lie between the individual and potential alternative sites, on the assumption that the individual will try to minimize those costs, whatever they are and however they are measured" (p. 755).

Despite their popularity, the "push-pull-obstacle" models have been criticized as analytic tools on several grounds.

1. J.S. Nelson (in Jackson, 1969:7):

The actual calculus of gain and loss which the potential migrant may work out can of course be subjected to the rational principles of minimax analyses, and, indeed, much of economic theory has depended on this. The rational element in the decision to migrate, however, is only partial and depends on the variations of personality, information, emotion and independence in attitude of the individual. The world view and perspective of the situation will vary markedly as will also the opportunities available to individuals to make moves. Consequently, however much it is possible to set out in broad terms the factors which predispose a given population to migration to particular destinations, this does not in itself serve to explain the variety of responses which may be made to the pressures to migrate. . . . In spite of the presence of all the factors of 'push' usually associated with heavy migration, people were unwilling to leave a social structure which appeared to them adequate and satisfying.

2. R.C. Taylor (in Jackson, 1969:99):

Imputation of motives, based on inference from structural factors, constitutes a denial of differential perception and evaluation, and places an excessive emphasis on purposive-rational behavior. . . . The 'push-pull' approach also subsumes all motives under the assumption of the maximization of want-satisfactions, so that the complex decision to migrate is reduced to a kind of mechanical balance of external and impersonal forces. . . .

3. Brinley Thomas (1973:2b):

. . . It is not by making a catalogue of such 'reasons' (pushes and pulls) that one can hope to understand the phenomenon of migration. . . . Nothing is easier than to draw up a list of factors labelled 'push' and 'pull' and then write a descriptive account in terms of these sets of influences. . . .

A modified push-pull-obstacle model

In most traditional societies, the perception of push-pull factors is a crucial problem. In some cases people are not able to move because their perceptions of push-pull factors at the origin and potential destinations are not strong enough to offset the barriers. In other cases people are not willing to move only because they do not perceive the existing push-pull factors. It is thus prudent for migration researchers, particularly those working in traditional societies, to depend on informants' own perceptions of the origin and potential destinations to understand their decisions concerning migration.

Push-pull factors will generate forces to move only if they are perceived by the potential migrants. Furthermore, the forces to move can make potential migrants move only if they are strong enough to offset the barriers to migration. The intensity of the forces to move depends on the strength of the operating push and pull factors at both origin and potential destinations, and on such personal factors as an individual's emotional and social experiences, sex, age, marital status, and education, which create a filter or mechanism for processing information about the push and pull factors. A modified push-pull model that incorporates these elements of the decision-making process is shown in Figure 5-4.

The modified model assumes that migration can only occur if the forces to move generated by the perceived push and pull factors at both origin and potential destination are stronger than the barrier forces. It also assumes that the strength of forces to move depends on not only the strength of push and pull factors at both locales, but also personal and socialized attributes of the person contemplating the move. Some examples of push factors at place of origin are low income, unemployment, underemployment, starvation, and boredom. Pull factors may include strong kinship ties or a strong bond to the present place of residence. Push factors at the potential destination may be such things as negative information from previous migrants about the destination, or official prohibition against entering the place of destination. Factors that often pull people toward a new locale are employment opportunities, the prospect of earning a higher income, and a milder climate.

Prior migration is defined as previous flows of people from the place of origin. It is included in the model because it has an important role, particularly in traditional societies. Other things being equal, the knowledge that some neighbors have already moved away tends to encourage other people to move. But its strength as a pull or push factor at the origin and the potential destination seems to be a function of both the success or failure of the prior migrants and the vulnerability of the potential migrants to these external influences.

Barriers include only the negative factors directly related to moving from the origin to the destination, such as transportation costs and the necessity of packing household goods.

The basic formulation of the quantification of the model is as follows:

$$F = \sum_k c_{ko} x_{ko} - \sum_l c_{lo} x_{lo} + \sum_j c_{jd} x_{jd} - \sum_i c_{id} x_{id} + c_{pm} x_{pm} - \sum_m c_{mb} x_{mb}$$

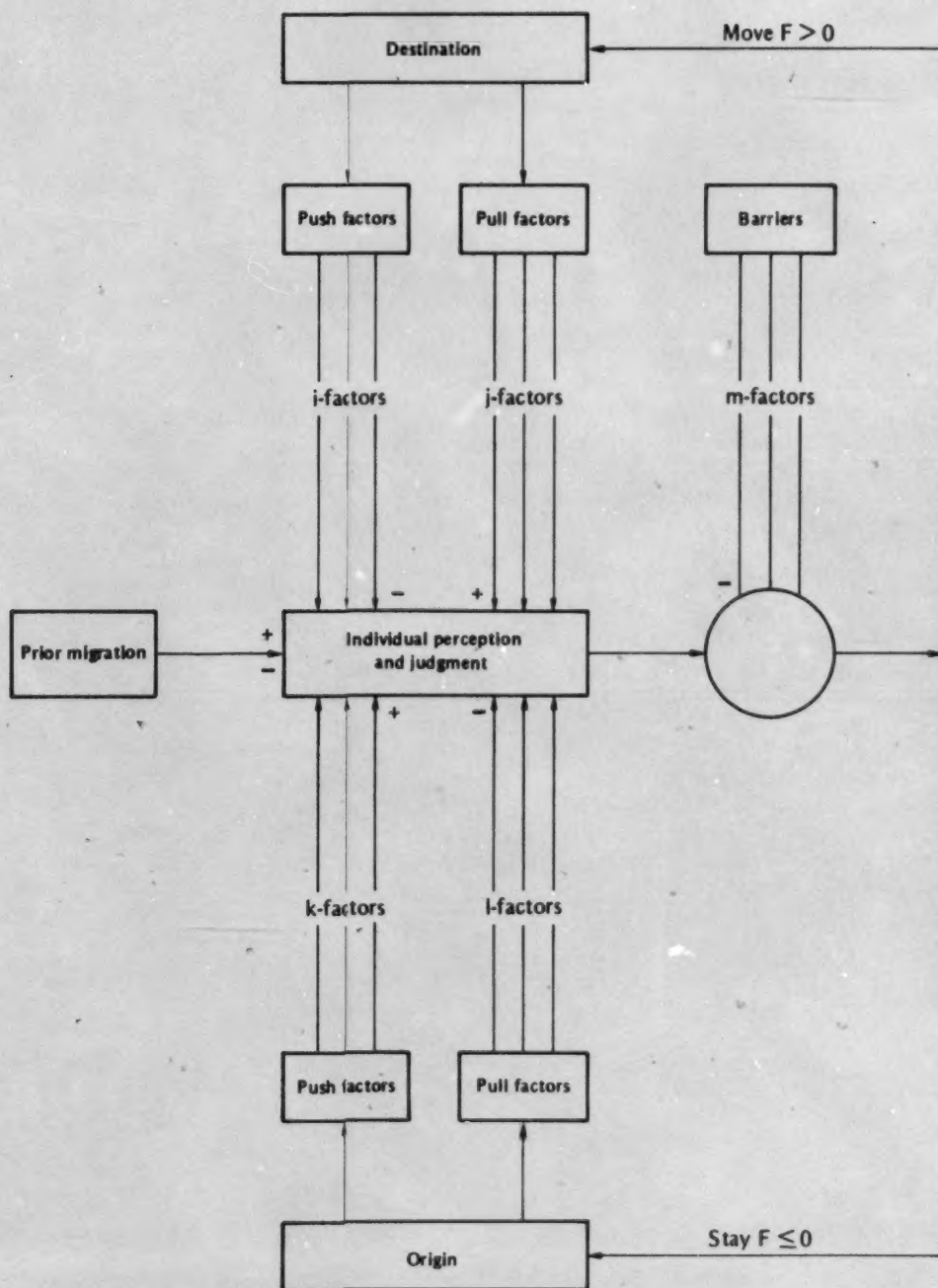
where:

F = forces to move

x_{id} = the quantity associated with push factors at the destination

x_{jd} = the quantity associated with pull factors at the destination

FIGURE 5-4. A modified push-pull model



- x_{ko} = the quantity associated with push factors at the origin
 x_{lo} = the quantity associated with pull factors at the origin
 x_{pm} = the quantity associated with either push or pull factor from the prior migration
 x_{mb} = the quantity associated with barrier/obstacle factors
 c_{jd} = weighting factor or perception cost associated with pull factors at the destination
 c_{id} = weighting factor or perception cost associated with push factors at the destination
 c_{pm} = weighting factor or perception cost associated with either push or pull factors from prior migration
 c_{ko} = weighting factor or perception cost associated with push factors at the origin
 c_{lo} = weighting factor or perception cost associated with pull factors at the origin
 c_{mb} = weighting factor or perception cost associated with barrier factors.

A move will occur if $F > 0$. A move will not occur if $F < 0$.

The way the potential migrant perceives and judges the push and pull factors at both origin and potential destination is the central element in the model. This conceptual framework places researchers in a difficult position, because they must attempt to understand the perceptions of others faced with a migration choice. Nevertheless, as Gould (1966:8) has observed, "a portion of our viewpoint is quite particular to ourselves, while another part is shared, or held in common, with many of our fellows." Besides unique and individualistic responses to the operating stimuli, there must be some generality and commonness. The proposed modified push-pull model is designed to enable us to understand both the generality and the uniqueness of human spatial behavior resulting from stimuli perception and judgment.

The role of personality in human spatial behavior is also discussed by Wolpert (1966: 93), who asserts that "migration is essentially human spatial response to the operating environmental stress" and proposes the following matrix:

$$A_t = L \cdot A_{t-1} + P_r \cdot S_r + \dots$$

where:

- A_t = the attributes of the individual i
 L = the life-cycle coefficients as they modify the set of n attributes during one time interval
 A_{t-1} = the attributes at the previous time period
 P_r = the coefficients of potential susceptibility of the individual to positive and stressful environmental elements at place r , depending upon the individual's set of n attributes
 S_r = a vector of positive or stressful environmental forces acting on the individual having a set of n attributes.

According to Wolpert, the product of $L \cdot A$ represents the development forces that modify the individual's attributes between time increments, and the product of $P \cdot S$ represents the additive influence on attributes that result from positive or stressful effects from the

environment. The individual will feel environmental effects in all r places that are conspicuous to him or her, but the effects will be of less consequence in proportion to their generalized distance from the individual. "Implied by the ecological model is that mismatching between the individual and his habitat may induce an escalation of stress and strain, a locking in on a process which accentuates the disharmony. But the converse process may also occur, whose consequences are to strengthen the attachments to places that may be far from suitable" (Wolpert, 1966:102).

There are several similarities between Wolpert's ecological model and our proposed modified push-pull model. In both, push factors at the place of origin can be environmental stress. In both, too, the individual's perception of environmental forces is the key element. The development forces that modify an individual's attributes between time increments and the additive influences on those attributes that result from environmental effects (Wolpert's $L \cdot A$ and $P \cdot S$) are reflected in the modified push-pull model by the way the potential migrants perceive and judge the push and pull factors (represented by a weighting factor in the individual's perception and judgment). Finally, both models face the same problem of identifying and measuring relevant parameters. The differences between the two models are that the modified push-pull model is simpler and gives a more distinct answer to the basic question: "When does a move occur?"

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6

Urban Population Problems

The most significant migration streams of this century have been those with destinations in urban areas, particularly large cities. In general, migration streams tend to be indicators of problems in source areas and causes of problems in destinations. This chapter considers the problems induced by population growth, particularly migration, on urban areas. These problems exist worldwide, and no country has been truly successful in solving them. To some extent, however, the problems associated with rapid urban growth are more severe in Asia than elsewhere. There are four reasons for this severity: (1) Large urban agglomerations have developed in most of Asia while the region still experiences high death rates. As these rates continue to fall, it is reasonable to expect an increase in the rate of growth. (2) The base populations of many Asian countries are much larger than those that existed in Europe, when Europe had similar vital rates. Thus, the absolute increase in population is likely to present unprecedented pressure on urban areas, greater even than that experienced in Latin America. (3) Asian cities, as centers of commerce and industry, tend to be legacies from the colonial era. With the notable exception of Japan, Asian countries must cope with problems that are literally foreign to their traditional ways of life. (4) The foreign origin of cities in Asia has contributed to the existence of two large city-states, Hong Kong and Singapore, which must cope with political barriers to physical expansion.

Despite the severity of the problem, the contributors to this chapter have resisted the temptation to provide only a litany of urban horrors. Rather, they believe that solutions can be found, and that geographers can help provide them. Their modest optimism is supported by the decisions of millions of people who continue to view urban areas, despite their problems, as providing advantages in the struggle for survival.

WHAT IS A CITY?

"City" can mean many different things. It can be a political unit, a settlement exceeding a certain population, an aggregation of dwellings and other structures, or a place with a great concentration of nonagricultural activities (administrative, commercial, industrial, or residential). But it is fair enough to say that it is economically and socially distinct from rural areas. Since its early history of development, a city has performed at least three functions that cannot be carried out with equal efficiency by noncity areas: it is an administrative, commercial, and communication center. A city occupies a central or nodal position through which administrative rules, innovations, and new ideas can be diffused to its surrounding areas and through which goods and services can be exchanged efficiently. (For definitions and functions of cities, see Murphey, 1954; Mayer, 1971; Davis, 1969; Ginsberg, 1972; and Milone, 1972.)

The most basic element of a "city" is its people. City people are generally distinct from rural populations because they live in higher population densities and within a more heterogeneous population. A city population is heterogeneous because it consists of people of diverse origins, backgrounds, occupations, personalities, aptitudes, and ways of life (see Mack and McElreath, 1973; Timms, 1971). Generally speaking, a rural society is a comparatively small and isolated one. (For discussions of rural-urban differences, see Wirth, 1938; Redfield, 1947; and Clarke, 1969.)

This basic element of the city—the city population—is not stationary, however. It grows and changes. It grows through natural increase, through in-migration from outside areas, and through changes in the city boundaries as neighboring areas are reclassified as urban. In Metropolitan Bangkok, Thailand, for instance, the population increased by 1.6 million during the decade 1960–1970 (Table 6-1). To a great extent, this increase was due to natural growth of the population, but in-migration to the city contributed a significant amount to the total increase as well. Goldstein has estimated that during 1960–1967, 65 percent of the population increase was due to natural increase and 35 percent due to in-migration (Goldstein, 1969:12, footnote 11).

TABLE 6-1. Population of Metropolitan Bangkok, 1900–1970

Year	Estimated population
1900	350,000
1947	781,662
1960	1,800,678
1967	2,614,356
1970	3,400,000

SOURCES: 1900: McGee (1967:74); 1947–1967: Goldstein (1971:216, table 5); 1970: Unger (1972:87).

The urban society changes because people's ideas and attitudes change. The concentration of heterogeneous people and the many different activities in a city promote numerous flows of information and the exchange of ideas. All these induce rapid changes in the ways of life and expectations of the people. Milone (1972:2) has pointed out that "today, the cities in Southeast Asia are being transformed. . . . There are several factors which appear to have brought about this transformation: technology and the forces which have been able to make use of it in the city, the scale and structuring of investment in the area, the motivational effects of mass media and mass channelizations, modern warfare and military planning, international organizations and aid programs and the promotion of higher education and family planning."

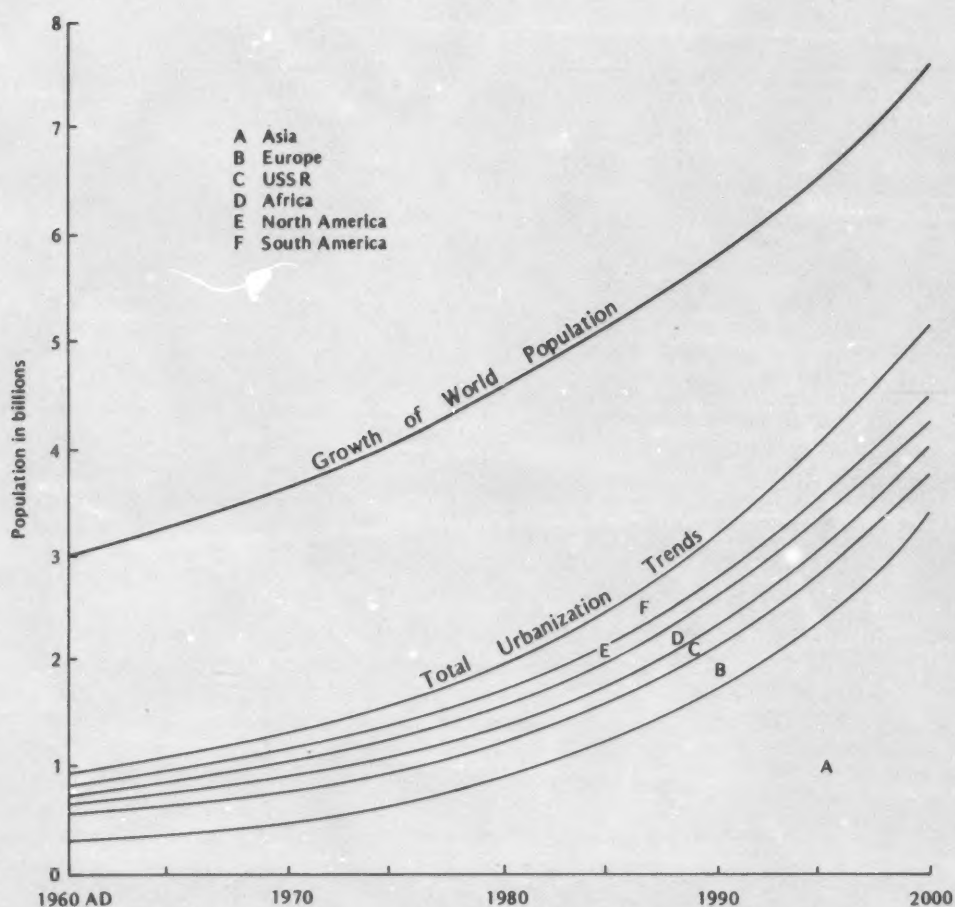
Changes in and growth of a city's population lead to demands for a reorientation or an addition of facilities provided in the city. An increase in the sheer number of people, for example, creates demand for more housing units, more jobs, more public and private transport, and more schools and medical services. As a society becomes more affluent, people expect more leisure, a better living environment, cleaner air, more open space, and recreational facilities.

When the legal and social institutions of a city (such as the police, educational system, and health facilities) fail to cope with these new demands, problems arise. Housing shortages, for example, characterize many big cities of the world, such as Calcutta, Bangkok,

Kuala Lumpur, Jakarta, Hong Kong, Lima, Chicago, and New York (see Abrams, 1964; Juppenlatz, 1970). Crime rates in the United States are positively related to city size (Haynes, 1973; Webb and Clemente, 1972). Big cities have had great problems with traffic congestion, environmental pollution, and even high rates of mental illnesses (Dotson, 1964; Versluys, 1964; U.N. Economic Commission on Asia and the Far East, 1971; Hassan, 1971). Ethnic segregations within cities have always been a latent source for the outbreak of violence (McGee, 1963, 1967; Goodman, 1971). These many problems have combined to make cities all over the world "sick" and aroused cries of "urban crisis."

Today, rapid urban growth is a world phenomenon (Figure 6-1), and cities in the less developed countries are growing even faster than in the more developed nations. According to Davis (1973:1-6, 219-223), the urban population in the developing countries more than doubled between 1950 and 1970, a rate of increase twice that of the developed countries (see also Weitz, 1971:5).

Figure 6-1. World urbanization trends



Source: Juppenlatz (1970:19).

The costs of providing enough housing, jobs, and social services for the growing urban populations are enormous. But most of the cities in the developing countries lack the technological and industrial development to support these costs. For this reason, urbanologist McGee has characterized rapid urban growth in the developing countries as a process of "pseudo-urbanization" (1967) and cities in the developing countries as "cancers" rather than "catalysts" (1969, 1971). To him, the urbanization process in the Western countries is a "true urban revolution" because it has been closely related to economic development, particularly industrialization. Rapid urban growth in the developing countries, however, does not indicate economic development, and is therefore not a "true" urban revolution (McGee, 1967:15-28). (See also Hoselitz, 1955 and 1957.)

SLUMS AND SQUATTER COMMUNITIES

Migration of rural people to cities can lead to another urban problem, adaptation of rural migrants in cities. Brody (1969:7) has described the problem of adjustment as follows:

A shift in residence involves not only new places, but new faces and new norms. Movement over distance implies the crossing of social system boundaries, whether the systems are defined in terms of national entities, regional subcultures, or immediate friendship and kinship networks. The migrant leaves his home village, he loses the support of social and geographic familiarity of long-term relationships and values which were built into him while growing up. . . . He is welcomed by the receptor networks or must deal with resistances in the host system to which he comes.

Change and adaptation, however, are not automatic. Some migrants may adapt well and become truly "urbanized." But those who fail to adjust are likely to experience maladjustment, which may find its expression in antisocial behavior, mental breakdown, drug addiction, or psychosomatic diseases (Hassan, 1971:53).

The process of adjustment depends on many factors: the type of persons migrating to the cities, the size and nature of the community of origin, occupational skills, linguistic and cultural affinities, educational attainment, housing facilities and welfare services, the prior expectations of the migrants, attitude toward the city, and the motivation or wish of the migrants to make a successful adjustment.

There have been some proposals for facilitating this adaptation of migrants to a new environment. For example, in Israel new migrants are asked to reside in communal camps where they are taught occupational skills and trained to adjust to the new life. After their orientation and training programs, the migrants are placed in specific jobs for which they are skilled, provided with housing, and integrated into the new community (Weintraub and Lissak, 1970; Laquian, 1969:7-8; and Juppenlatz, 1970:39-41).

Application of this type of structured program to rural-to-urban migrants is possible only when certain conditions are present. First, there must be a means of controlling the internal movement of people; administrators must know who the migrants are, where they come from, and where they intend to go. Second, there must be a means of supporting the rural-to-urban migrants while they are undergoing the training process. Third, the economy and society must be planned so that the placement of the migrants in appropriate jobs, residences, and recreational groups could be efficiently and effectively done. It is doubtful, however, whether such a program can practically be carried out in most of the developing countries because it necessitates such heavy drains on the administrative and financial resources of city governments.

Sometimes, however, slums and squatter communities act as the transitional communal camps where people may be able to change without any formal instructional methods (Laquian, 1969:35). There are at least two reasons for this. First, slum and squatter communities are in many cases "rurban" human settlements where social norms and patterns of behavior still possess both rural and urban characteristics. A study of slum areas in Metropolitan Manila (Laquian, 1969), for example, has shown that the communities there tend to retain many of the traditional characteristics of rural life: "a feeling of community solidarity; intensive face-to-face dealings; groupings according to ethnic, kinship, or economic ties; closed communication systems characterized by localized gossip; and a strong 'we feeling' felt against the outside world" (Laquian, 1969:35). Thus, the slum can act as "a buffer mechanism permitting [a new migrant] a pause for personal and social reorganization before making his way into the larger cosmopolitan urban environment" (Brody, 1969:11). Second, most rural migrants to cities are poor compared with native urban residents. Economically, slums and squatter communities provide them with a chance to survive. When a male migrant first arrives he may stay with his relatives, friends, or people who came from his own village or town. Later on, after he has a job and has accumulated some savings, he may be able to construct or rent a hut of his own. If he is more fortunate and can save more money as time goes on, he can afford to improve his structure or to move out to a better section of the city. It is in this way that migrants can gradually be integrated into the economic and social system of the city.

The planners' views of slums and squatters are different, however. To them, slums and squatters are sources of diseases, fire hazards, riots, crimes, and social disorder; they obstruct the proper development of the cities because they occupy some of the most valuable pieces of land, which could be more economically and productively used for other purposes. Squatters are illegal because they do not pay land rents or land taxes. The huts are usually poorly constructed, unsanitary, and unsafe. The population of these areas constitutes a potentially dangerous political mass, because their economic and housing grievances offer a "fertile ground for revolutionary propaganda" (Abrams, 1964:287). Therefore, squatters must be removed.

Planners and administrators who share this view of squatter settlements have probably never experienced the sadness of having their own homes demolished. It is doubtful that many government officials have gone out of their air-conditioned offices to look into the actual life of the squatter people. Moreover, forced removal of squatters is difficult to achieve. The clearance and relocation of squatters in Manila have not been successful (Laquian, 1969). Attempts to evict squatters in other Asian cities have faced tremendous resentment and threats from the squatter-dwellers that they would defend their huts at all costs (McGee, 1967:160; Abrams, 1964:23).

Not all squatter settlements are a threat to social stability. In Kuala Lumpur's *kampong* (squatter area) for example, "the problems were remarkably few, even though its levels of income were low; an average of \$100 Malayan per month; job stability was high, unemployment low; and in general, the squatter *kampong* gave every impression of rapid adaptation and assimilation to the problems of the urban environment. It could by no means be labelled a 'settlement of misery', but rather a 'settlement of necessity'—a necessity brought about by the lack of adequate city housing" (McGee, 1967:165). In Vientiane, Laos, "crimes in these [squatter] areas do not exist at all. The slum people are law-abiding, more so than the people who are not slum-dwellers. The slum people cooperate with the local administration. In many ways, they are well organized. . . ." (Weitz, 1971:59).

Why, then, do most people have the impression that squatters are nuisances? The problems of squatters are, in fact, probably a creation of the administrators rather than of the squatter dwellers themselves. Since squatters are "illegal," the administrators have hundreds of justifications for ignoring their existence and not providing them with such social amenities as drinking water supplies, electricity, paved roads, public transport, public health services, and police patrols. In Hong Kong, for instance, even the efforts of squatter people to improve their environment by enlarging their tiny huts or hoeing some open space to plant flowers are thwarted since such activities constitute illegal occupation of land. The voluntary improvement of their living environment is also hampered by the general feeling of instability of life, for the government reminds squatters that their huts can be removed at any time.

Do squatter dwellers like living in this kind of squalid environment? One study of the *kampung* in Kuala Lumpur and another of the *barriadas* (squatters) in Lima, Peru, have shown that they do not. Contrary to general opinion, "the *barriada* dwellers are well organized, politically sophisticated, strongly patriotic and comparatively conservative in their socio-political view. . . . As soon as the residents can afford to, they convert their original straw shacks into houses of brick and cement. . . . They have shown a really remarkable capacity for initiative, self-help and community organization" (Mangin, 1973: 233-234).

Squatter dwellers are capable of carrying out organized activity and of improving their living environment provided that such opportunities are given to them. *The New Yorker* has pointed out that "squatting . . . is not to be understood as a totally lamentable phenomenon. . . . In some respects . . . the squatter enterprise is probably the most significant form of home-building taking place in the world today" (quoted in Urquidi, 1968: 90). Hopkins (1969:293) has asserted that in Hong Kong "the dilapidation of the huts in the squatter sites could easily be improved by a slight change of government policy. If Government declared that these settlements were not going to be cleared, say, for the next ten years, and if it removed the embargo on building solid walls of brick or concrete, the squatters would probably, like squatters elsewhere, invest considerably in improving their property." Perhaps it is time for planners and administrators to make their policies more humane and consider more seriously the *needs* of this sector of urban populations.

PROBLEMS OF ETHNIC DIVERSITY

Confrontation between different ethnic groups within a city can lead to serious political crises. In a study of Kuala Lumpur, McGee (1963:193) pointed out that Malays and Chinese were not only residentially segregated, but also culturally separate. He concluded: "A policy of cultural compromise, which seems to be a graft of Malay culture onto the other cultural elements of Malaya . . . was piecemeal, and showed little understanding of the richness of cultural diversity in the country. . . . It is rather like trying to build a dam across a large river without engineering equipment or constructional plans. The results might well be disastrous!" (McGee, 1963:194)

To achieve the aim of integrating the different ethnic groups into one national unity, policy makers have to know to what degree the groups are segregated and why they are so before any policy is formulated and implemented. Policies formed in ignorance of this knowledge can cause costly political upheaval. The racial riots between the Malays and Chinese in Kuala Lumpur in May 1969 were a tragic example of what McGee had predicted. During these riots, hundreds of lives were lost and thousands became homeless.

Suppose that a government wants to integrate different ethnic groups. The administrators must be able, as a first step, to convince the groups that none of them will be discriminated against and that all will be equally treated. The concept of "social equality" or "social justice" is difficult to define. It is absurd to assume that income and wealth can be equally distributed among all the people in a noncommunist state (or perhaps even in a communist state). A factory owner, for example, should generally earn more than an ordinary factory worker. But social justice can be interpreted as the provision of equal opportunities for all people to make use of the "common goods" of a society. In Malaysia, non-Malays may conclude that they are being discriminated against if they do not have the same employment opportunities in entering the civil service or a proportionate share of scholarships in the universities as do Malays. It is similarly legitimate to argue that the squatter dwellers are being discriminated against because they do not have access to basic public amenities that are provided in areas of higher status.

To a great extent, the provision of equal opportunities in employment, education, social welfare, and medical care to different groups depends on the political, economic, and social systems in society. But it is also a matter of the locational strategies of public facilities. In Northern Ireland, for example, the construction of a government-owned factory in a predominantly Protestant area of the city would arouse suspicions among Catholics, just as its construction in a predominantly Catholic area would arouse suspicions among Protestants (Douglas, 1968).

To avoid discrimination against subgroups of the population, a government must therefore formulate "just" locational strategies for public facilities. Analytical techniques such as factorial and social-area analyses have been employed by geographers to study the spatial and social structures of urban areas. (For comprehensive reviews of these techniques, see Herbert, 1973:121-186; Yates, 1974:207-238.) Findings from these analyses can offer insights into how people organize their "space" and how far they are segregated from one another, so that equitable locational schemes of public facilities can be postulated.

CONTROL OF URBANIZATION

The process of urbanization in the developing countries must be controlled (or planned), but how are governments to control it? Are "anti-urbanization" policies possible? Some who believe that urbanization plays an important or even vital role in the attainment of development goals in developing countries have denied the practicality of controlling growth. Murphey, for example, has asserted: "Less urbanization would probably be worse than more. . . . It is, after all, in cities that economic growth concentrates, especially the kind which Asia is currently seeking—industrialization. . . . With some obvious exceptions, there are probably not more productive uses for capital or for labor in most Asian countries than in the cities, and investment there probably yields quicker returns and with multiplying effects" (Murphey, 1969:65).

Moreover, even if a government has closed, by law, all the "doors" of a city to newcomers, migrants will still try their best to slip in. The Indonesian government, for instance, has spent much effort to control the growth of Jakarta, without success. In 1905, the government began enforcing programs of "transmigration" to promote the flow of migrants from Java.¹ In 1971, the government declared the city of Jakarta "closed" to any further

¹ Although the original purpose of transmigration was to reduce population growth on the densely populated island of Java, the policy also aimed at slowing growth in its major city of Jakarta. Both natural increase and in-migration have contributed to Jakarta's rapid growth in recent years.

influx of unemployed villagers. Since then, persons wanting to migrate to Jakarta have had to produce evidence of prospective employment and an official release from their place of origin (McNicoll and Mamas, 1973:37).

As a strategy for alleviating Java's population problem, the transmigration programs have been unsuccessful. (For a theoretical discussion of their efficacy, see Keyfitz, 1971.) Their effect on growth in Jakarta has been nil. Available information on the number of people who moved from Jakarta under government sponsorship between 1966 and 1967 shows that there were virtually none; and between 1968 and 1969, only four families comprising 22 persons transmigrated (Indonesia, Biro Pusat Statistik, 1971:40). Since 1971, the year in which the "closing" of Jakarta to new unemployed in-migrants became effective, the city's population has increased at a rate of 6.5 percent a year (Otico, 1974: 56). City officials estimate that about half of the present annual growth results from migration (McNicoll and Mamas, 1973:33).

It is evident that a government's decision to close a city to new migrants or to remove people already settled there is not likely to be effective. Such a policy reflects an ignorance among policy makers of the reasons why people migrate to the city. Only by knowing why people migrate is it possible to induce them to stay in their villages or towns by providing there some of the services they desire. A successful control of urbanization requires action not only in the cities, but in noncity areas as well.

Much has been said about squatters and the adjustment problems of city in-migrants. But the social problems of cities do not occur overnight, nor are they due solely to the arrival of rural migrants. Various studies (e.g., by Zlotnick and Altman, 1972; Hawley, 1972) have demonstrated that social problems are closely related to the consequences of overcrowding in the cities—although researchers have not yet agreed on a definition of "overcrowding." Crowding has been reported to cause diseases, physical malfunction, mental illness, crime, riots, war, drug addiction, alcoholism, family disorganization, psychological withdrawal, aggression, and depressed quality of life (Freedman, 1973:209). Some researchers have formed contrary views, however. Freedman, for instance, has asserted: "Density probably does not have overall negative effects on human beings. . . . Instead, it suggests that whatever effects density does have will probably turn out to be quite complex, will depend in large part on the particular situation, and may also depend on characteristics of the individuals involved" (1973:232-3). But he admits that "other factors that tend to accompany crowding are, of course, very serious" (p. 233). Although we do not know the effects of density *per se* on social problems, many conditions that are directly related to high population density—such as noise pollution, poor ventilation, and lack of privacy—are known to have serious adverse social and psychological effects on human behavior.

Population density has two forms—physical and social. Physical density is measured by the resident population per unit of land space; social density, by the amount of interaction between people (Hawley, 1972:522). The more closely people are crowded together, the higher the physical and social densities. In situations of high social density, individuals interact frequently with others and are under greater psychological stress.

In Singapore, for example, the suicide rate, computed on the basis of the mean annual number of suicides for the years 1968 and 1969, was highest in areas where high-density building flats were located (22.6/100,000 population 15 years and above). The great majority of suicides took place within the limits of the central city and the town areas where high-density building estates were located (Hassan, 1971:60)

The consequences of high population densities have implications for planning, especially for the construction of high-rise public housing. It is likely that redevelopment of existing housing will bring higher population densities. To accommodate an increasing population and the various activities within a city, land must be move intensively used. What concerns people is whether there should be a limit or standard for maximum densities in order to maintain the "quality" of life within the city.

HONG KONG AS A CASE STUDY

Hong Kong has long been famous for its high population density. The metropolitan area of Hong Kong, which contains over 4 million people in less than 13 square miles of land and comprises four-fifths of the total population of the Colony, has the highest urban density in the world: about 250,000 persons per square mile, or ten times the density of New York City in 1960 (Hopkins, 1969:275).

The housing shortage in Hong Kong is acute. Large numbers of squatters have existed in Hong Kong since the early 1950s. The Hong Kong government has tackled the squatter problem by resettling the squatters in public housing estates. This policy has resulted in a decrease in the squatter population since the mid-1960s (Table 6-2). The Resettlement Department was established in 1954 to plan the estates, screen the resettled people, maintain the resettlement blocks, and "control" squatter areas.

TABLE 6-2. Population of squatter areas in Hong Kong
(selected years)

Year	Squatter population
1950	250,000
1953	300,000
1956	265,000
1959	500,000
1964	546,000 ^a
1967	486,100
1970	358,641

^a Bishop (1971:113) gives a population of 603,200.

SOURCES: 1950-1964: Hopkins, 1969:279; 1967-1970: Bishop, 1971:113.

Although the resettlement program has constructed housing for many people, initially the living space per person was minimal—only 24 square feet (Hopkins, 1969:300). Allocation of room space in resettlement blocks built after 1972 has been increased to 35 square feet per adult (Government of Hong King, 1973:100). (A child under 10 years of age is allocated half the space of an adult.) As children grow up and family size increases, the density per family unit becomes much higher than the official standard of 24 or 35 square feet per adult. A 1968 survey found that one-third of the households in resettlement estates had less than 24 square feet per adult (Hopkins, 1969:302). In 1971, the former assistant commissioner for resettlement reported that the average number of persons per room in resettlement estates was 6.8, and that the floor area per person was only 17.7 square feet (Bishop, 1971:120).

The earliest resettlement blocks were built to house thousands of squatter dwellers

who were made homeless by a fire in December 1953. Designed rapidly and intended for immediate needs, they were constructed six to seven stories high with communal toilets and washing rooms, but with no provision for cooking space and no electricity. Nevertheless, this design persisted for ten years (until 1964), and by the end of 1972 public housing of this type with communal facilities was accommodating 46 percent of the resettled population, numbering some 540,000 people (Government of Hong Kong, 1973:100).

The housing built since 1964 comprises eight or sixteen-story blocks, in which accommodation consists of single rooms. Amenities have improved considerably, with the provision of a private balcony, water tap, toilet, and electricity.

However, rules governing allocation of space until 1969 remained as inadequate as ever at 24 sq. ft. per adult, 6 ft. by 4 ft.—twice the area of a grave—for living, eating, sleeping, cooking, playing and often for working as well. Each block contains 2,000 people; humans are piled on top of humans to achieve an average net density of 2,200 persons per acre (in some estates the density reaches 4,000 persons per acre). (Hopkins, 1969, p. 297)

Dr. K. Singer, medical superintendent of Castle Peak Hospital in Hong Kong, wrote in 1967: "My own impression is that there is high incidence of schizophrenia in high density areas in Hong Kong [compared with lower density areas]. Also, living conditions in such areas aggravate the symptoms of neuroses, but do not actually increase their incidence" (Rosenberg, 1968:425).

In 1962, R. Worth surveyed groups of children in the New Territories villages and the resettlement estates in Kowloon (part of metropolitan Hong Kong) and concluded that air-borne infection and especially tuberculosis increased with crowding—that is, with room densities, but not with densities of persons per acre. His study suggests that there is no harm to physical health in very high residential densities, as long as there is enough space per person in the rooms. What Worth noticed about the resettlement estates, as compared to the squatter areas, was the very great increase in noise (Worth, 1963).

Although there may be no harm to physical health, what about mental health? And what about the many social problems related to the consequences of overcrowding? Goodstadt, a sociologist, found that "social tensions are increased in moving to resettlement estates. While settlers are, in general, as law-abiding as the rest of the community, the rate of common assaults is significantly higher amongst them than in other parts of the city. Similarly, the proportion of family disputes is almost twice as high in estates as in the rest of the urban community. . . . there are proportionately more juveniles on probation from resettlement estates than the rest of the Colony. . . . All in all there is strong evidence that on the estates there has been a weakening of social values and controls and a rise in social tension" (Goodstadt, 1969:288–289).

Comparing rates of tuberculosis, infant mortality, maternal deaths, juvenile delinquency, and adult crime for Hong Kong in 1961 with those for the United States, Schmitt (1963) found that those for Hong Kong were not significantly higher. He concluded that "the experience of Hong Kong proves that an urban population can survive and even flourish under conditions of density and overcrowding that today seem unthinkable to many Americans. High morbidity, mortality, and social disorganization rates have not proved to be an inevitable corollary of these conditions" (p. 216). But a resident of Hong Kong is more likely to be concerned with the quality of his or her living conditions, relative to others in Hong Kong, than with how they compare with housing in a country thousands of miles away.

THE ROLE OF GEOGRAPHY IN URBAN PLANNING

More knowledge is needed about the consequences of high densities on living conditions. One of geographers' long-standing concerns has been the identification of the distribution of population and population densities through such techniques as cartographic mapping. Today, with the development of techniques for aerial photo interpretation, it is possible to produce three-dimensional maps of cities (Lo, 1970 and 1971). By identifying the places with the highest densities, these offer new opportunities for planning and for formulating further research.

To solve urban problems and make cities better places to live, cooperation is needed from all citizens. To take a simple example, the dumping of industrial wastes into the upper course of a river means that the people in the lower course will have to use polluted water. A compromise in the use of the natural resources must be negotiated among the city people. Guidelines are needed from governments, since many issues requiring decision-making—such as mass transportation and land use zoning—are out of the control of individuals. These guidelines, which can be called public policies, imply a governmental effort to pursue specific goals for bettering the welfare of the people.

The formulation of policy is the responsibility of government administrators and planners. Geographers, who are trained to identify and analyze human activities in a spatial and temporal context, can play an important role in the policy-formulating process. As we have seen, many urban problems have locational attributes, an understanding of which is invaluable if policies are to be responsive to human needs.

Geographers have much to contribute to the planning process (see Mayer, 1968; Taffe, 1970). The following contributions are most obvious:

1. To analyze the spatial distribution of a city's population, thus providing a reference for administrators to plan for the people. The distribution of people has both static and dynamic features. For example, the size and structure of a population at a particular time is a static feature, whereas the processes of migration and intra-urban mobility of people are dynamic features.
2. To discover the problems, to find out where the "problem" areas are, who the "problem" people are, how many there are, and why they are problems. In Seattle, for example, the expansion of the Black ghetto can be predicted by geographical analysis (Morrill, 1965).
3. To suggest or forecast the best places to locate such "problem-solving" institutions as schools, medical centers, and public housing. In Sweden, for instance, geographers helped to decide the location of two new hospitals so that the aggregate distance to these facilities could be minimized (Godlund, 1961).
4. To evaluate the possible impact (or impacts) of public policies on the areas and people affected. In Hong Kong, for example, geographers have been active in evaluating the government's policies of new town development and mass transport systems (Lai and Dwyer, 1964, 1965; Leung, 1971). (See also White, 1972a, 1972b.)

Among the possible contributions of geographers to the planning process, the most important is the provision of information about the spatial features of human problems. This information is crucial to the achievement of the goals set by policies, but it is lacking

among most administrators. The remainder of this section will discuss some of the spatial dimensions of urban problems that have generally been ignored by city administrators, citing specific examples.

Using the technique of social area analysis and data available in census tracts, it is possible to distinguish several subgroups of the urban population in San Francisco (Shevky and Bell, 1955). Maps drawn from social rank scores reveal that families of the highest status reside in the southern part of San Francisco, whereas the lowest status families are located in the central and northern parts of the city. The greatest degree of ethnic segregation is found in the eastern and northeastern parts of the city.

With factorial analysis, greater numbers and more complicated variables can be handled, and more comprehensive patterns of social groupings of an urban population can be differentiated. In Tampa, Florida, subgroups of the urban population have been identified through the mapping of the factor scores obtained from analyzing a large number of social well-being variables (Smith, 1973:120-134). The population having the lowest socioeconomic status, most serious social problems, and greatest racial segregation is found around the central part of the city.

Knowing where and what the problem areas are, administrators can formulate better policies. In reducing discrimination or social injustice among different groups of an urban population, at least two strategies must be followed: (1) identification of the different needs of people in different areas of the city, and (2) implementation of a policy to distribute public facilities so that every sector of the urban population has an equal opportunity to use them. (For an in-depth discussion of this issue, see Harvey, 1973.)

Since an urban population is not evenly distributed, and different people have different needs, it is naive to strive for an even distribution of all public amenities. What is required is the location of facilities so that they can be used by different sectors of the population in the most efficient and equitable manner. Information on the spatial dimensions of society, which geographers are best qualified to provide, is crucial to the successful formulation and implementation of such problem-solving policies.

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7

Laborforce Mobility in Asian Countries

Relatively little research attention has been devoted to labor force mobility and its significance in the process of socioeconomic development. The importance of internal migration in general and labor force mobility in particular was recognized at the Conference on Administrative Implications of Rapid Population Growth in Asia held in Manila in May 1971. In a paper prepared for the conference, the Secretary-General of the Economic Commission for Asia and the Far East (ECAFE, 1971a:10) stated:

The subject of internal migration is a highly complex one. Many more studies are required in order to usefully exploit this propensity and to ameliorate many of its harmful aspects. In general terms, it may be said to be a spontaneous effort by the inhabitants to achieve a more equitable balance with resources, economic opportunities, and satisfactory social conditions. The task this presents to planners and administrators is herculean, but it is uniquely one of their functions.

The purpose of Part 7 is to report implications of labor force mobility for economic development in selected Asian countries. The term labor force refers to the number of persons who could produce goods and services if there were a demand for their labor and if they desired to participate in such activity. The labor force is usually considered to include people between the ages of 15 and 65. The term mobility as used here refers to the spatial mobility of the labor force and may or may not involve social or occupational mobility. Moving from one farm or village to another, for example, involves spatial mobility but not occupational mobility.

Available data indicate that more than 50 percent of the population growth of larger cities in developing countries is due to migration (Table 7-1). Most of the Asian countries are still in the disequilibrium stage of demographic transition, which is characterized by high fertility and low mortality rates that result in high rates of natural increase (2.5 percent or more per year). Although the rates of natural increase in most rural populations are higher than those of urban areas, population growth is more rapid in the urban areas because of rural-to-urban migration. Experts warn that the redistribution process under way in Asian countries raises problems in almost every field of development (ECAFE, 1967).

In the next two sections, rural labor force out-migration and its effects on the socioeconomic and demographic conditions of places of origin and places of destination are examined. Finally, some policy implications of labor force mobility will be discussed.

TABLE 7-1. Estimates of migrants as a percentage of recent population increases in selected cities

City	Period	Total population increase (thousands)	Migrants as a percentage of total increase
Abidjan	1955-63	129	76
Bombay	1951-61	1,207	52
Caracas	1950-60	587	54
	1960-66	501	50
Djakarta	1961-68	1,528	59
Istanbul	1950-60	672	68
	1960-65	428	65
Lagos	1952-62	393	75
Nairobi	1961-69	162	50
Sao Paulo	1950-60	2,163	72
	1960-67	2,543	68
Seoul	1955-65	1,697	63

SOURCE: IBRD (1972:80).

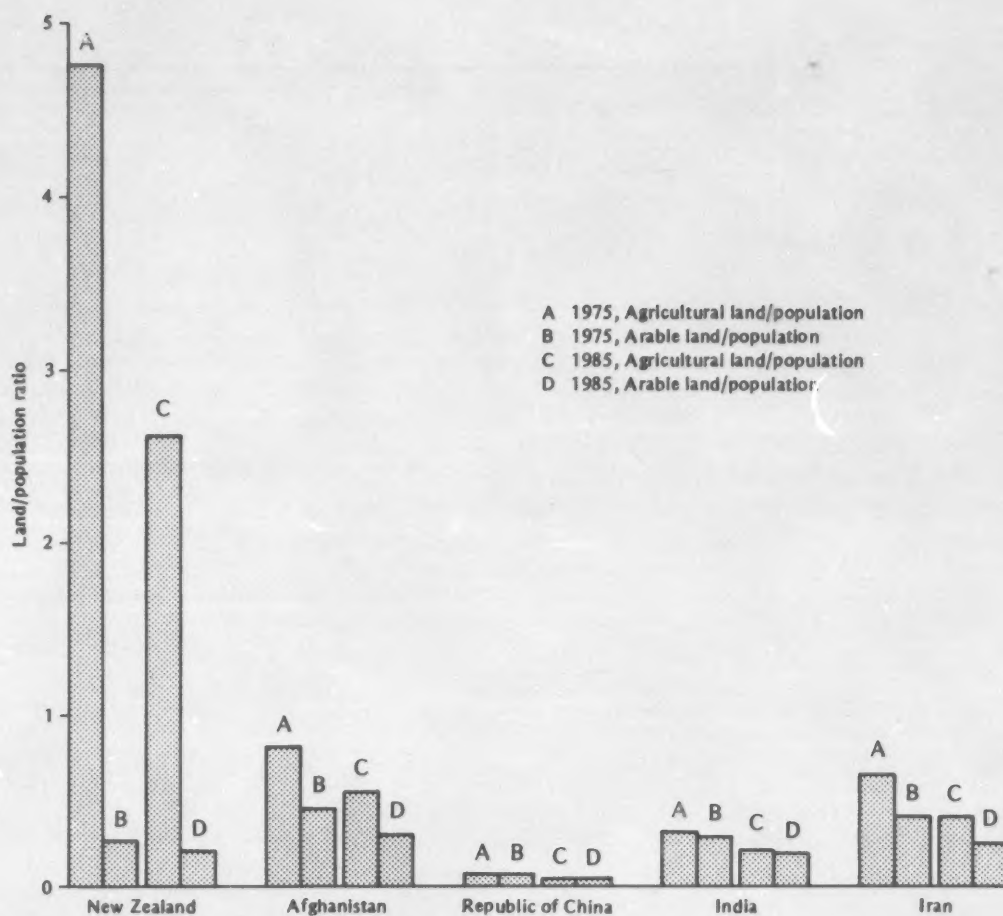
LABOR FORCE OUT-MIGRATION FROM RURAL AREAS

The basic assumption of the push-pull hypothesis of migration is that people tend to move from socioeconomically depressed environments to places that promise chances for improvement. Empirical studies of rural-to-urban migration in developing countries indicate that economic considerations often in fact underlie the decision to migrate. Migration streams into Bagdad, Bombay, Bangkok, Singapore, and Teheran were explained best by economic factors (Speare, 1971; Burford, 1970; Zachariah, 1966; Hemmasi, 1974b). Among the salient push factors that induce rural laborers to migrate to cities are limited agricultural resources, lack of employment opportunities in the rural areas, natural disasters, social forces, the land tenure system, and the relative impoverishment of the rural area. Each is discussed in some detail below.

RURAL POPULATION PRESSURE

Rural population pressure on limited agricultural resources is already severe in many developing countries, particularly in Asia, and is likely to increase in coming decades. The projections shown in Figure 7-1 suggest that the amount of agricultural and arable land available for individual farmers to cultivate will be much less in 1985 than in 1970. In some southwestern and southern Asian countries where insufficient land may not be a major problem, lack of water for agricultural use, fertilizers, and modern technology retards agricultural expansion and demand for labor. The present low level of agricultural productivity and labor efficiency may become still lower by 1985, leading to a higher number of unemployed farmers who will have to seek jobs in urban centers. Labor surplus in the rural sector of most Asian countries is not a by-product of technological development and the substitution of machines for human labor. Mechanized agriculture, use of

FIGURE 7-1. Land/population ratios in countries of the ECAFE region: 1970 and 1985 (projected)
(Hectares per person)



chemical fertilizers, improved seeds, and pesticides are being introduced in a few farming stations usually operated by the government or large landholding companies. Most farmers still practice their traditional agricultural techniques, which are characterized by low productivity per worker and per unit of land.

Under such circumstances, rural out-migration of labor can be beneficial if the surplus rural population is successfully transferred to the nonagricultural sector of the economy. But the only developing country in Asia that apparently has been able to benefit from its rural labor surplus is Taiwan, with its dynamic economic development planning and industrialization policies adapted in recent decades (Speare, 1971; Burford, 1970).

Rural-to-urban migration tends to be sex and age selective, with the majority of migrants being in the labor force age groups and either male or female, depending upon the region. The loss of young adults may exacerbate the problem of lower agricultural productivity and economic stagnation in small towns, but it is not yet clear how much of the recent decline in agricultural output in less developed countries can be attributed to this phenomenon.

LACK OF ALTERNATIVE SOURCES OF INCOME

Recent industrial development and technological innovations have not generally provided job opportunities for rural or small-town artisans. Traditional household industries and handicrafts such as pottery, copper and blacksmithing, and cloth and carpet weaving have faced severe competition from the mass production of similar goods in cities. As a result, many small-town and village artisans have been forced to give up their usual sources of income.

NATURAL DISASTERS

Natural disasters have induced human migration throughout history. Recurring droughts in southwest Asia, droughts and floods in the Indian subcontinent, and earthquakes, erosion, and landslides in most of the Asian countries have often forced rural people to look for their livelihoods in cities. The influence of natural disasters on migration has not received sufficient attention from geographers and seems to be an open frontier for migration research.

SOCIAL FORCES

Marriage, military draft, and transfer have been reported by migrants as reasons for their relocation. Immediately after marriage one of the partners, usually the wife, moves to live with the spouse in his or her village or town. This kind of move is usually over a short distance and often involves rural-to-urban migration. Its prevalence cannot easily be measured by aggregate census results but becomes clear when micro-level surveys are taken. The migration of heads of households often generates the movement of entire families. Most migrants are the spouses, children, or other members of the family who are dependent on the principal migrants, that is, on the heads of households. Migration because of military duty usually involves a small percentage of young male adults. Many draftees do not return to their villages after termination of duty; instead, they try to find work in cities.

THE LAND TENURE SYSTEM

The land tenure system traditionally has been one of the main factors influencing rural-to-urban migration in Asia. Although there are a variety of ways in which land tenure can influence migration, perhaps the most common way is through the implementation of land reform laws. These measures, increasingly common since World War II, have taken land ownership away from wealthy landlords (who often were absentee owners) and vested it in those resident upon the land. Often the new owners lack the capital or the technology to farm their land efficiently, or the land parcels may be too small to permit production at the subsistence level. The new owners then, having escaped exploitative rents, may find that they cannot escape the limits to their productivity and therefore seek new opportunities in the cities.

More serious is the plight of the landless agricultural worker under land reform schemes. The transfer of ownership from large landowner to peasant virtually guarantees short-run turmoil in the agricultural sector. One of the first consequences in the change of land tenure systems is the reduction of the demand for labor external to the family unit. Although such demand may eventually increase, the landless worker does not have the resources to survive for long without employment. Thus, the city seems to offer the only survival prospect.

GAP BETWEEN VILLAGE AND CITY

Rural areas in Asian countries are far behind the urban centers in schools, hospitals, recreational facilities, piped water, electricity, and other services. Low levels of income coupled with the shortage of modern facilities cause many educated villagers to seek better opportunities in the cities. For similar reasons, urban professionals and technicians in the developing countries are reluctant to work in rural areas. The problems of the rural sector are thus perpetuated. In a study of migrants to Bombay, Zachariah (1966) found that their educational level was superior to that of the general population at the place of origin but inferior to that of nonmigrants residing in Bombay. Hemmasi (1974b), analyzing inter-provincial migration in Iran, found that services in the place of destination acted as an influential pull factor for migrants. Furthermore, more modern counties tended to lose a higher number of migrants to Teheran than the less developed counties.

LABOR MIGRANTS IN THE CITY

The problem faced by cities in the less developed countries as the major destination of migrants is far more serious than the condition created in the places of origin. Although it is often argued (e.g., by Stockwell, 1968) that migration allows people to adapt to their environment, this may not be generally true in most Asian countries. Despite the efforts of developing countries to modernize their economies, their cities are unable to absorb the rapidly growing numbers of people seeking full productive employment. The labor surplus has several causes. One is that the rates of national population growth and labor in-migration are greater than the rate of industrial employment in the cities. Singer (1973: 31) has observed, for example:

Industrial employment in the modern sector is not increasing at the rate of 7.8 percent (the average increase in modern industrial production) but at the far lower rate of around 3 percent. Since total population also increases at a similar rate of close to 3 percent per annum, this means that there is practically no structural change in employment at all.

A second cause is that most industrial establishments in the developing countries are capital intensive rather than labor intensive. Oshima (1971:164) has pointed out that in

most Asian countries "most of the new industries appear to be no more than semi-assembly plants which import a large part of their basic equipment and material inputs, producing goods which compete with traditional production, with very few linkages to tertiary sector." Because of these trends, both migrants and natives in many cities suffer from economic, social, and environmental problems caused by imbalances between supply and demand of labor. The services or "miscellaneous" occupations are the ones that are taken most often by these laborers.

OCCUPATIONAL OPPORTUNITIES FOR MIGRANTS

Rural-to-urban migrant laborers, while they may be more educated and skilled than rural nonmigrants, are relatively disadvantaged in the cities to which they move. The work participation rates of migrants were reported to be lower for every age group than for resident nonmigrants in a Bombay study (Zachariah, 1966). The migrants were also concentrated in industries and occupations that require less skill, less education, and less capital than those employing nonmigrants. Elizaga (1966) has reported that in Santiago, Chile, male and female migrants received less pay than nonmigrants, even if they were engaged in similar jobs. These findings suggest that the average laborer who has been unemployed for some time before moving to the city is willing to accept almost any kind of job to survive in the new, unfamiliar environment.

The effects of migration on health and migrants' physical and psychological reactions to the urban environment have not been studied thoroughly. But because migrants often face poor housing conditions, low income, an inadequate food supply, and substandard water and sewage facilities, they may be more susceptible to illness than the nonmigrant segment of a population. According to information collected on the average monthly expenditure of slum dwellers in Bagdad (Baali, 1966), medicine and medical treatment comprised the second largest expense for this group. There are also signs that as the rates of population growth have increased in Asian cities, the incidence of accidents, delinquency, theft, and mental disorder has also increased, a phenomenon observed in cities of other regions.

SETTLEMENT PATTERNS OF URBAN MIGRANTS

Housing shortages are one of the immediate consequences of unplanned, rapid urban population growth in the developing countries. Slums and squatter settlements exist in almost every Asian city of over 500,000 inhabitants. Most of the shantytowns are occupied by migrants who, because of their substandard income level, are not able to secure better accommodations for their families.

Migrants tend to settle in groups and to be segregated from the native population of cities to which they move. Conditions in these predominantly migrant districts differ greatly from those of native residential areas. They usually have higher birth and death rates, as well as inferior occupational structures, overcrowding, and lower income levels.

Despite the troubles an average resident of a city in a developing country may face in his daily life, the rate of out-migration to other areas is still generally low. One study of squatters in Shiraz, Iran, found that although migrants were not completely satisfied with conditions in the city, they preferred their new situation to the one they had left (Beheshti, 1972). The same study reported that migrants had endured poverty and destitution at their place of origin for an average of two years before moving. The low rates of

return migration in many Asian countries suggest that most migrants consider their opportunities to be better in the cities than in the rural areas they leave.

POLICY IMPLICATIONS OF LABOR FORCE MOBILITY

It is likely that present city-ward labor force mobility will continue in Asia during coming decades. Some of the advantages and disadvantages of this process have already been mentioned. The social, economic, and environmental problems caused by rapid urban growth are a matter of increasing concern to governments. Despite their efforts to adopt appropriate coping strategies, such as land reform, accelerated industrialization, and decentralization of administrative and economic growth, problems remain. (For strategies adopted by the Iranian government, see Hemmasi, 1974a.)

Among a host of related reasons for the failure of policies aimed at ameliorating the problems of cities, the following seem to be more important:

1. The approach of governments toward the problem of population redistribution has not been comprehensive enough in scope. Because migration is a complex phenomenon, its regulation needs a systematic approach that takes into account all of the elements involved in the act of migration. These include the migrants themselves, their perceptions, the origin and destination as part of a larger universe (i.e., the nation), and finally, the intervening obstacles and opportunities. Government strategies have usually been directed at only a few of these elements.

2. Where policies have been comprehensive, implementation has been weak. In the stratified Asian societies, any change that may adversely affect the interest of the upper class is likely to be defeated.

3. Western industrial technology, as a strategy of economic development, often has disruptive effects on the traditional labor-intensive industries of Asian countries.

4. The agricultural sector has not received adequate attention from governments and planners of economic development in many Asian nations. Policies have too often favored industrialization at the expense of agriculture, but even the industrial sector may suffer from insufficient capital and skilled labor.

Friedmann and Sullivan (1974) argue that radical departures from existing social organization in most developing countries are needed to bring about conditions favorable to full employment and to regulate population redistribution. They propose six new emphases: "(1) development objectives: from maximizing growth of gross national product to maximizing human potential; (2) economic organization: from a system based on inequality to one of greater equality and social justice; (3) external relations: from foreign dependence to greater national autonomy and self-reliance; (4) industrial organization: from import substitution to an explicit policy of industrial dualism; (5) regional development: from urban primacy to balanced rural-urban development; and (6) population policy: from high rates of natural increase to stabilization." The particular strategies for implementing these will vary from country to country depending on the stage of economic development.

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8

The Contribution of Geography to Family Planning Research

To date, the geographic community has contributed little to family planning research. That this is so is surprising because family planning can be viewed from a number of perspectives touching on the traditional interests of geographers. In addition, these perspectives are supported by a substantial body of theoretical and applied research. For example, family planning can be viewed as a service, the spatial location of which is explained by theories of location analysis. Family planning can also be viewed as an innovation that exhibits spatial characteristics, especially the diffusion of adoption of the innovation. Similarly, family planning can be considered a communication process wherein the information networks, nodes, and links possess areal characteristics and are influenced and shaped by spatial factors. Alternatively, it can be viewed as a process of movement, involving the executors of the program on the supply side and the public on the demand side. Finally, family planning can be viewed in the context of spatial variations in infrastructural and socioeconomic variables related to fertility control performance.

Because so little work has been done by geographers in this area, the purpose of this section is to outline family planning research to which geographers can make a contribution. The discussion does not attempt to be definitive but rather to conceptualize some of the problems confronting the geographer who wants to engage in family planning research.

FAMILY PLANNING AND THE USE OF MODELS

The use of models and systems approach has provided a new angle of study. Morris (1967) outlines the process of modelling where, first, a problem in its full-blown messy reality is apparent and, unable to deal with the complexities of this reality, one retreats to an abstraction of the relationships and interactions of the situation, which then becomes a model. According to Skilling (1964), a model can be a theory, law, hypothesis, structured idea, role, relation, or equation; or it can be a synthesis of data. From the geographical point of view, a model can reason about the real world by means of translations in space (spatial models) or in time (historical models). McLaughlin (1972:3) stresses that models are the "intellectual skeleton for administrative discussions as well as the muscle for academic research and field experiments." He classifies the role played by models as:

- (a) defining and describing the system
- (b) delineating the degree of abstraction that is appropriate
- (c) achieving more quantitative (although not necessarily less qualitative) system descriptions
- (d) forcing agreement or disagreement on realistic assumptions

- (e) influencing the decision-making process analytically, conceptually, or behaviorally
- (f) heightening sensitivity to observed data
- (g) focusing interdisciplinary activities
- (h) specifying topics that require research
- (i) relating family planning to frontier activities in academic disciplines

For application to the study of family planning programs one can choose from a long list of models, ranging from cost-benefit analysis to the diffusion of contraceptive practice and the application of marketing theories. The Carolina Population Center at Chapel Hill has a host of research designs applicable to family planning studies. The POPSIM model (Carolina Population Center, 1971) and the Quicktest Model for Computer Gaming (Carolina Population Center, 1972), by which the effect of a family planning program on the birth rate and population growth of a country can be predicted, are examples. Inputs are standard demographic data—e.g., total population, recent birth and death rates, size of the female population by age group, and age-specific birth rates. Although diffusion theories were originally associated with the diffusion of information and confined to communication science (Rogers, 1962), Hägerstrand's (1967) simulation of the spatial characteristics of the diffusion process has initiated geographical interest in diffusion studies. Topics related to family planning, in particular the location of clinics, the spread of birth control, and areal variations in fertility decline, have been examined from a diffusion perspective (Casetti and Demko, 1969; Fuller, 1972; Blaikie, 1975; Parsons, 1973; and Hanham, 1974). McLaughlin (1972) has suggested marketing models for the study of family planning programs, and Brown (1974) has extended some marketing concepts to the diffusion of family planning agencies.

It must be remembered, however, that models and systems designs are generalizations of reality that are valid on paper only. The scale on which models are valuable and the standpoint from which they are constructed make them either broadly significant only, or parochial in view of reality. Haggett and Chorley (1970:26) warn that simplification might lead to "spurious correlation; suggestiveness to improper prediction; approximation to unreality; and analogy to unjustifiable leaps into different domains." They discuss some of the limitations and problems in the use of models and concepts in geographic studies of family planning programs.

FAMILY PLANNING AND SPATIAL DIFFUSION

The question of whether birth control, especially contraception, is an innovation or an adjustment process is still open to debate (Carlsson, 1966). But in most areas of the world such technological developments as the oral contraceptive and the intrauterine device (IUD) can be viewed as innovations, although differing in important aspects from the types of innovations that have traditionally concerned the diffusion specialist. For example, whereas most innovations encourage behavior having positive results, such as planting improved varieties of rice to obtain higher yields, family planning calls for behavior that produces essentially negative payoffs, at least in the short run, for the nonproduction of children which can be viewed as a decrease in productivity. Similarly, the advantages of adopting agricultural or social innovations are often quite visible and readily recognized, whereas adopting contraception has less immediately tangible benefits. Furthermore, acceptance of family planning requires a change in deeply held cultural values that are not usually affected by the adoption of other innovations. Thus, any study of the diffusion of family planning must take into consideration a variety of constraints not associated with the acceptance of other types of innovation.

In examining the contributions geographers have made to diffusion research, let us first review the place of spatial diffusion theory within the general body of diffusion theory, with an emphasis not so much on how well the spatial models predict patterns as on the processes assumed to operate in the model and whether or not these actually occur in the case of family planning. Second, let us examine the utility of the spatial diffusion models for planners engaged in fertility reduction programs.

ASSUMPTIONS OF SPATIAL DIFFUSION MODEL

The theoretical underpinnings of the spatial diffusion model are embodied in the writings of the Swedish geographer Torsten Hägerstrand (1966, 1967a, 1967b, 1968). On the basis of his research of agricultural innovations in Sweden, Hägerstrand viewed the diffusion process essentially as an information or communication phenomenon wherein the diffusion of an innovation results primarily from the spread of information about an innovation through spatially constrained personal contact networks. This emphasis on the information component of the diffusion process suggests that Hägerstrand's model describes a spatial information process rather than an adoption process, which would imply a greater concern for the decision-making component.

Resistance to adoption of an innovation in the spatial diffusion model is viewed by Hägerstrand as a function of the frequency of exposure the individual has to relevant information concerning the innovation. Exposure, in turn, is a function of the individual's proximity to the sources of information, the dispersion of which is governed by what he referred to as the *neighborhood effect*. The neighborhood effect, of distance upon the amount of contact between innovators, knowers of the innovation, and others who are ignorant of it, has been well documented in the sociological and geographical literature. In geography, where it has been examined primarily at the aggregate rather than the individual level, the spatial characteristics of the neighborhood effect are summarized by the distance decay function.

The spatial characteristics of the neighborhood effect pertaining to the transmission and reception of information—referred to as the *mean information field*—have been well researched by geographers because these characteristics rest at the core of the spatial diffusion concept (Marble and Nystuen, 1962; Bowden, 1965; Morrill and Pitts, 1967; Marble and Bowlby, 1967; Mayfield, 1967). The mean information field represents a cone of declining probabilities of contact with increasing distance from the transmitter of information about the innovation to any other receiver. Various surrogate measures of the mean information field have been suggested, such as telephone calls and marriage distances, but their relevance to particular innovations has been questioned (Parsons, 1973).

The weakness of the core concept of the mean information field is not so much that it does not hold true in all cases as that it tends to be overly simplistic and is based upon assumptions that cannot stand in the light of prevailing evidence. For example, movement fields and contact circles vary from one type of individual to another. Information and innovative behavior can be brought to new communities by specific types of people, such as the cosmopolite individuals, group leaders, opinion leaders, and information brokers. As a result, innovations often jump spatially according to the size of the information and movement fields of community leaders rather than the size of the *mean* information field of the community as a whole. In the Indian family planning context, Blaikie found that kinship and marriage customs were of greater importance in the formation of information networks and are probably more accurate and less crude indicators of family planning diffusion than is mere distance (Blaikie, 1972a). Fuller found in his study of birth control

in Chile that kinship ties similarly influenced the nature of the networks of communication of family planning information (Fuller, 1972). In his study of a single Philippine barrio, Parsons discovered that networks of interpersonal communication and interaction were strongly affected by kinship ties, although the spatial element, especially the physical distance separating individuals in the barrio, was highly influential in determining networks of interaction. Neither kinship nets nor spatial proximity was particularly useful in explaining the diffusion of family planning information in the barrio, however (Parsons, 1973). On the other hand, viewing the diffusion process at an aggregate rather than individual level, both Fuller and Parsons discovered that distance to the family planning clinic was an important variable influencing the total number of family planning adopters from different locations within the study sites (Fuller, 1972; Parsons, 1974).

Another shortcoming of the mean information field concept is that each of the five stages in the adoption process—awareness, interest, trial, evaluation, and adoption—generally involves different sources of information. For example, impersonal sources of information such as the mass media, which generally originate outside the neighborhood and perhaps outside the mean information field of the community, are often more important at the awareness stage than at any other. The extent to which this is true in the diffusion of family planning is open to debate, for as Rosario (1971) and Schramm (1971) have argued, personal contact is the principal information source at all stages of the adoption of family planning. Even where the mass media have engaged in public information campaigns about family planning, however, the importance of interpersonal, face-to-face channels has not yet been determined. The point is that various types and combinations of information sources may operate among different categories of potential adopters at different stages of the adoption process. The fact that geography's spatial diffusion model is formulated almost exclusively on informal channels of information appears to be overly restrictive and perhaps simplistic.

Just as each of the five stages of the adoption process may involve different channels of information, so too may the various categories of adopters—that is, the early adopters, the early to late majority adopters, and the laggards. In India, for example, Blaikie (1972a) found that early adopters used impersonal communication channels more frequently throughout all stages of adoption than either majority or laggard adopters. The problem is further compounded because an individual may be an early adopter of one type of contraceptive but a laggard by adopting another contraceptive at a later stage (Fliegel, Kivlin, and Sekhon, 1968).

Similarly, an invariate mean information field postulated for a whole population is unable to accommodate what Katz (1957) hypothesized to be the "two-step flow" of information into a community; namely, information that passes first to a person or persons with cosmopolite or extracommunity contacts and second from these to others in the community via local channels.

Another shortcoming of the basic concept of mean information field is that it fails to take into consideration different types of information, each of which may move through different networks of varying spatial structures and characteristics. Thus, certain types of information may be transmitted and received more readily by some people than by others (Marshall, 1971; Rahim, 1965). For example, information about agricultural innovations is likely to pass through networks of farmers rather than through nonfarmer networks. Information about maternal and child health practices undoubtedly diffuses more readily through networks of married women than among unmarried women or males. There is still inadequate evidence of how family planning information spreads. In some cases, it may

flow through a combination of males and females or it may pass entirely along kinship lines. In addition, information about family planning methods used by one sex or the other—for example, the pill, the IUD, and the condom—may travel exclusively along sexually defined networks which may in turn have very different spatial characteristics. In traditional societies where female mobility is restricted, the diffusion of female methods of contraception could be expected to be spatially limited and slow to branch. On the other hand, where contact nets of males are more widespread, diffusion of information concerning male contraception could be expected to be wider and faster.

In short, then, the assumptions made by the spatial diffusion model concerning the spatial characteristics of information transmission and reception may be unrealistic and in need of reformulation given what is known in other disciplines about the nature of communication. As Blaikie (1972c:8) cautions:

Because the [family planning] innovation is "private" with a conspicuous lack of demonstration effect (in fact the only effect is a *lack* of children and absence is not the most obvious form of demonstration) information on FP [family planning] is very often prone to rumor. FP also is seen to ask questions about—even meddle with—issues which are very basic to every human being. The fear of promiscuity engendered by FP practice (identical to that voiced at the end of the last century in the U.K.), scandal, religious interpretations and views, local folk lore or sexuality and so on, all tend to filter and introduce noise to the essential family planning message. This situation is quite alien to the diffusion of agricultural innovations. Any study of the diffusion of FP must be prepared to look into the context of the messages and relate them to the individual and his role in his society in more detail than is necessary for agricultural innovations.

Another general area of weakness of the spatial diffusion model stems from its assumptions concerning the nature of the decision-making process involved in adopting an innovation. Hägerstrand hypothesized that individual resistance to the adoption of an innovation is a function of the number of times that person is exposed to relevant information about the innovation. But this assumption is too simple and tends to run counter to a vast body of literature, particularly in rural sociology, in which it has been demonstrated that younger, more cosmopolite, literate, less traditional, more mass-media oriented, and richer farmers innovate more quickly than their opposite (Greenberg, 1951; Back, 1958; Bose, 1961; Fliegel, Kivlin, and Sekhon, 1968; Rogers, 1962, 1969; Brien et al., 1965; Weintraub and Bernstein, 1966; Jones, 1967; Rogers and Shoemaker, 1971). Because many of these variables are known to vary over space, resultant spatial patterns of adoption may be the product not so much of areal differences in the flow of information about the innovation as of areal variations in these other social variables. For example, out-migration tends to leave older farmers in peripheral areas on marginal farms (Lerner, 1958; Caird and Moisle, 1961). Other studies by Gilbert (1972), Hill (1967), and Anderson (1967) have shown spatial variations in education standards. Most national atlases are replete with cartographic evidence of the spatial variation of social variables over quite small distances. It is widely accepted, especially in Asia, that the social gradients from primate cities to rural areas and even between cities themselves vary markedly. Yet little work has been done to determine the significance of such gradients on innovation patterns.

Aside from the effect that areal differences in these socioeconomic and psychological variables may have on spatial patterns of innovation adoption, variations in general medical care and infant mortality may contribute significantly to explaining spatial discontinuities (Blaikie, 1972b, 1972c). Likewise, patterns of adoption may be influenced by a variety of cultural factors, such as the adopter's fear of being the subject of gossip if seen by friends or neighbors while visiting a family planning clinic. Parsons suggested this as a partial ex-

planation for the spatial anomalies discovered in rates of family planning adoption of various localities in a Philippine municipality (Parsons, 1974).

In conclusion, the contribution of the spatial diffusion model to family planning research lies in its focus on the areal configuration of the diffusion process, which many researchers have overlooked. The model is more concerned with the diffusion of information about an innovation than with the adoption process, however; and when viewed in light of the latter, the model makes too many unrealistic assumptions that are not supported by a vast amount of research undertaken in other disciplines.

UTILITY OF THE SPATIAL DIFFUSION MODEL IN PLANNING

What relevance does the spatial diffusion model have for planners engaged in family planning programs? Unfortunately, very little, since the model as it now stands assumes that the diffusion process develops "naturally" with little outside intervention in the process. If we discount certain predefined constraints, such as the neighborhood effect and physical and social barriers to the diffusion of information about the innovation, the spatial diffusion model employs a Monte Carlo approach to simulating spatial patterns of adoption through time: it assumes that the process by which the innovation diffuses is essentially random.

Nevertheless, many innovations in agriculture, public health, industrial practices, consumer behavior, and family planning are actively supported in an organized manner by private and public sectors of society. The element of randomness, which is part and parcel of the geographer's spatial diffusion model, thus may not adequately represent the manner in which the diffusion process occurs. The spread of an innovation is seldom left to develop naturally. Of critical importance, therefore, is the study of the location of "change agencies"—agencies that already exist as well as those being planned for maximum effectiveness.

On the other hand, the spatial diffusion model does provide planners with a useful cartographic technique for highlighting irregularities in the spatial pattern of adopters. The location of family planning adopters, which may not be perceived to be of direct importance to the planner, may in fact give some indication of the process by which diffusion is occurring. For example, Blaikie (1972a) found that the clustering of Lippes loop acceptors over time in India was much greater than that of vasectomy acceptors in the same area. This discovery prompted the hypothesis that communication about the loop is spatially "sticky" and does not flow freely. That the clustering was concentrated in villages close to primary health centers and health subcenters prompted alternative hypotheses concerning the difficulty of long journeys to have the loop fitted in a strange and potentially embarrassing situation. Or, the location of extension input might have been limited to within a small radius around the health center (Blaikie, 1972a:9-10).

Another example of how the spatial diffusion model can be suggestive of the process by which diffusion occurs is found in Parsons's (1974) study of pill acceptors in a Philippine municipality. Calculating adoption rates at four-month intervals over a two-year period for some 25 barrios in the municipality of Torrijos, he found that the spatial pattern of acceptors assumed a wavelike motion throughout the study area over the two-year period. This suggested that the flow of information about the pill and the family planning clinic was constrained both by distance from the clinic and by characteristics of the potential adopters. In addition, his analysis indicated that two of the four closest barrios to the clinic and the town in which the clinic was located had proportionally fewer acceptors than

would have been expected given the distance decay function. This finding prompted a number of hypotheses about why such a situation might have occurred, including the possibility that potential acceptors living near the clinic may have been embarrassed to have others see them seeking family planning assistance.

RESEARCH NEEDS

Before turning our attention to the general topic of research needs, it might be useful to examine the issue of geographic scale and the level of aggregation at which much of the research on the spatial diffusion model takes place. Generally, the study of the diffusion of innovations has concentrated at two levels. On the one hand there are decision-making models, which tend to be concerned with disaggregated units at the small geographic scale. These have traditionally been the interest of sociologists and, to a lesser extent, psychologists. On the other hand, models of spatial form, such as the Hagerstrand model, have focused on aggregations in large-scale geographic units. The preoccupation of geographers with modeling the spatial outcomes of a particular phenomenon has tended to oversimplify the decision-making process and the individual behavior giving rise to the process. As geographers focus on lower levels of aggregation and reduce the geographic scale of their investigations, diffusion studies will begin to examine in more detail the decision-making process as a spatial phenomenon. Research is most urgently needed at the meso, rather than micro or macro, scale where individual, community, and spatial factors, such as patterns of travel between communities and geographic variability in message transmission and reception, can be examined. Geographers have much to contribute to this type of research.

What are some of the specific areas of research suggested by this discussion? First, geographers need to examine more closely the nature of resistance surfaces and social gradients from one location to another and the causes of these gradients. Questions worth investigating are whether the causes are rooted in attitudinal or communication variables, how and why social characteristics vary over space, and what is the feedback from socioeconomic variables to the networks and composition of communication. Second, geographers need to investigate more fully the diffusion of family planning information and compare this process with the diffusion of other innovations. Since the acceptance of family planning impinges on many cultural beliefs and practices, and involves a greater psychological change and commitment on the part of acceptors, what is known about the diffusion of other innovations may be inapplicable to this particular innovation. Third, we need to take a closer look at general diffusion theory rather than merely theories of information diffusion. Greater sophistication is needed in dealing with the decision-making process and the correlates of that process that may have spatial meaning and variation.

An interesting development in the diffusion school of studies has been the introduction of the concept of marketing. Brown (1974) contends that previous research on innovation diffusion has generally examined the adoption of the innovation, which is actually the third stage in the diffusion process. The first two, according to him, are the establishment of the diffusion agencies (e.g., family planning clinics) and the implementation of a strategy to induce adoption. These two stages "control the availability of the innovation to potential adopters, and, broadly speaking, may thus be seen as the *supply* side of diffusion. The adoption step is then the *demand* side of diffusion" (Brown and Gustavus, 1975:1). Brown's application, in collaboration with others, of marketing concepts to study the diffusion of innovations has covered a range of products and services, from pesticides and insecticides to baby food, credit cards, cable television, and Planned Parenthood services.

Marketing strategies have already been used to promote contraceptive practice and awareness in the developing world. Examples are the Nirodh (condom) marketing scheme in India (Jain, 1973) and the marketing of condoms in rural Kenya through existing commercial channels (Black and Harvey, 1976). Marketing of contraceptives, particularly of condoms and spermicides, like other consumer products, requires product pricing, packaging, distribution, and the creation of product awareness. In the developing world, where outreach family planning workers visit village homes to create awareness and to supply clinical and nonclinical contraceptives, the marketing of contraceptives becomes the marketing of family planning services. One point to note here is that, whereas in the commercial marketing of contraceptives the location of retail outlets or clinics is important, in the marketing of services, the size of the network of outreach workers and their location in relation to the client population becomes important. Moreover, whereas commercial marketing is suitable for nonclinical contraceptives, for the promotion of clinical contraceptives the fieldworkers have to be trained to encourage social and behavioral change (from large- to small-family norms) among their clients. The recruitment, training, and field supervision of these change agents; the anticipation of the family planning needs of the population; and the supply of services to match the needs become an exercise in social marketing, rather than commercial marketing. For an explanation of the broadening of commercial marketing to social marketing and the application of the latter in family planning, see *Journal of Marketing* (1969, 1971).

What significant role can geographers play in the implementation of social marketing strategies in family planning programs? Just as research in location analysis was extended to the study of business locations and health and family planning clinic sites, it can now be extended to the study of optimal locations for family planning workers. The difference, however, is that accessibility of client populations will be examined from the viewpoint of fieldworkers, whereas previously the accessibility of the clinic was examined from the viewpoint of the population (Ali, 1978). Studies of physical accessibility have generally analyzed transport networks (Lal, 1974; Wilbanks, 1972). The accessibility of village populations is still to be studied. Planners in some countries, anticipating the problem faced by fieldworkers in reaching clients, have provided them with bicycles (Java), motorbikes (Thailand), or motor scooters (Java). Such transport helps to overcome the physical distance between fieldworkers and their clients, and it enhances their mobility within the service area, allowing a greater frequency of home visits. Geographers can use their training in movement and transport to map travel time and distance between workers and the clientele assigned to them, to calculate the shortest path network (Abler, Adams, and Gould, 1971) for workers, and to find the optimal locations for workers, whose shortest path networks together will cover all the villages efficiently.

The problem of fieldworker accessibility to clients is not one of travel time and distance alone, however. In countries where the population is largely homogeneous in language, religion, and caste, attempts at maximizing physical accessibility through the provision of transport to fieldworkers may have positive results. In Thailand it is reported that when fieldworkers were employed, the number of annual acceptors rose from 60,000 to 300,000 in two years, from 1969 to 1971; and in Indonesia home visitors were responsible for 60 percent of new acceptors. In countries with heterogeneous populations (e.g., India), the problem of physical accessibility is compounded. The shortest path network for fieldworkers in Indian villages would outline the most efficient range of home visits. Not all the villages within the range would be socially accessible, however (Ali, 1978). Social and cultural studies of the population as well would have to be combined with the study of physical accessibility to demarcate the range of field tours for individual workers, thereby segmenting the demand market for family planning.

Population geographers can also segment the demand market into high-priority and low-priority couples, whose acceptance of family planning has different effects on the birth rate, depending on their age and parity. For example, in India, where the program goal is to reduce the country's birth rate substantially and quickly through a national family planning program, family planning services should be aimed at young couples with one or two children only. Effective birth control by them can lead to a more significant reduction in the birth rate than birth control practiced by older couples. Another example of market segmentation is found in the United States, where the problem of an increasing number of unmarried pregnant teenagers (and a consequent rise in the rate of abortion among them) can be combated by contraceptive education of preteen sectors of the population and the supply of contraceptive services to high school students and adolescents.

The director of the Louisiana Family Planning Program specifies that in developing an effective family planning program, first priority should be given to the study of the client population. Information on clients is to be collected through a set of questions which, although socioeconomic, are also clearly geographical: "Who are those in need of services? What are their characteristics? Where do they receive their medical care? Where do they deliver their babies? What family planning services now exist? How many poor persons currently have access to effective family planning services?" (Beasley, 1969:2).

In considering distance to clinic, optimal locations for service centers (either clinics or fieldworkers), and the spatial variations in the supply of services with respect to the distribution and demographic characteristics of the client population, marketing strategies also suggest potential collaboration from population geographers. Geography thus offers a fruitful perspective that can identify heretofore unrecognized and overlooked relationships and suggest alternative directions for policy planning.

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9

Graphical Displays and Remote Sensing

Cartography is so integral a part of geography that geographers are in general identified as map makers. Their concern for spatial relationships has made geographers emphasize graphical devices like maps, diagrams, and graphs. Population geographers are not the only students of population who employ these graphical devices for reference and analysis, although they do employ them extensively. Remote sensing and satellite imagery in particular have been more readily accepted by geographers in their study of populations than by demographers, although the inclusion of a session on remote sensing at the 1975 annual meeting of the Population Association of America was a step forward.

This chapter discusses the application of graphical devices in population analysis. First, the problems of data availability and accuracy are noted briefly and the cartographer's responsibility of communicating the meaning of the data is discussed. Next, some of the popular and notable methods of data representation are selected for discussion and instructions are given for constructing them.

Two kinds of problem are associated with the graphic portrayal of population data: those having to do with the availability, adequacy, and accuracy of data, and those concerning the communication of data. It may be said that the cartographer inherits the first type of problem, for he or she cannot help the defects of existing data. Because it affects the final map product and the message conveyed to the reader, it deserves attention. Overcoming problems of communication, on the other hand, is the direct responsibility of the cartographer.

ADEQUACY OF DATA

Before tackling the problem of data adequacy, let us clarify what types of data we will be dealing with. Clarke (1972:7) has identified two kinds of demographic data: "the state of the population at any given time, including its geographic distribution and its structure or composition," and "the movement or dynamics of population in time and space, i.e. its growth or decline by the actions of fertility, mortality and migration." The main sources of these data are census and survey statistics and vital registers. Censuses (which may be taken on a *de jure* or a *de facto* basis) give a static or time-specific set of data for ascertaining population structure and distribution. Vital registration of births, deaths, marriages, divorces, migration, and changes in employment provides more dynamic or continuous records for measuring population changes and migration patterns over time.

In many countries of the developing world, census and vital registration data are in-

complete, irregularly collected, or inaccurate. The bane of the population mapper is thus not only lack of data, but also unreliability of existing data.

A census is taken at periodic intervals, usually every decade. Information is collected by a host of enumerators, selected and briefed for the purpose, who visit individual households and obtain data by direct interview. When there is inaccessibility to an area, failure to identify specific households or groups of people, lack of public cooperation, public unawareness, or unqualified enumerators, census coverage is likely to be incomplete. On the other hand, through error some segments of a population may be enumerated twice.

Vital registration data are even less reliable than census results. In countries where birth and death registration is not compulsory but left to voluntary efforts, coverage tends to be poor. Moreover, in cases where only births or deaths are registered, the data become inconsistent and distorted. The United Nations (1955:4-5, 18-20) has reported that many countries base their vital statistics on the time of registration rather than on the time in which the event occurred. Where significant changes in the timing of such events take place, these reports may be misleading.

Even if coverage is nearly complete, the reliability of data can be suspect. Where the public believes that census information is used for purposes of taxation, rationing, military service, old-age pensions, or other benefits or obligations, reporting is far from truthful. Illiteracy, superstitions, and social customs in some populations may bias data. For example, if respondents do not know their exact ages, they may express them in even numbers or in multiples of 5 and 10. Children no longer living may not be mentioned in response to a question about the total number of children borne by a mother. In birth and death records, the misreporting of sex is a minor error compared with the misreporting of age. When the ratio of male to female births appears unusual, it probably implies that reporting for one sex has been more complete than for the other. Similarly, registration is more complete among urban, literate populations.

The United Nations Statistical Office considers the evaluation of census results to be a requirement of good census practice. "Methods for measuring the extent of error include re-enumeration of a sample of the population covered in the census, overall comparison of census results with data from independent sources, usually administrative records; matching of census documents with other documents for the same person; and demographic analysis, which includes the comparison of statistics from successive censuses, analysis of the consistency and the analysis of census data for interval consistency and reasonableness" (Shryock and Siegel, 1973:55-56). By the time these checks are made and the data processed, tabulated, verified, and reviewed, a considerable time has elapsed between the date of census taking and date of data publication. In more developed countries the process is speeded up with the help of equipment designed to transfer data from microfilmed copies of the questionnaires directly to computer tapes. Elsewhere, however, the data are published in serials, as the processing takes place. Even so, three or four years may elapse before any substantial data are made available for researchers. In the absence of quinquennial censuses or intercensal surveys, the data are not updated until the next decade. This list of problems inherent in data collection is by no means exhaustive. But a general acquaintance with the sources of error in population data should suffice to alert us to the possible dangers in data analysis.

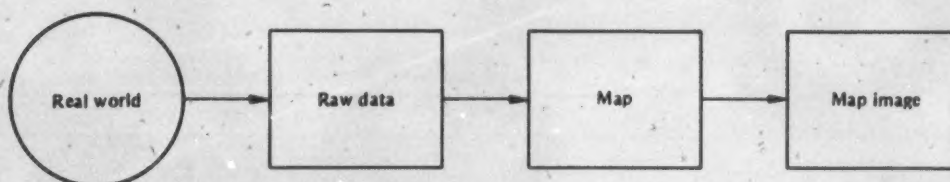
COMMUNICATION OF DATA

Maps are used to communicate geographical relationships. When they are used to convey relationships between particular types of data, they become thematic maps. The mapping of population data falls into this category.

According to Kormoss and Kosinski (1973), population maps date back to the 18th century, but advances in population cartography have taken place more recently with greater availability of demographic data. The techniques conventionally used for population mapping have drawn attention to population distributions, densities, structures, and movements over major areas of the earth. Not surprisingly, areas with more reliable and complete population records have been studied by cartographers more extensively than areas for which data are scanty. Scandinavian and West European countries have developed considerable mapping sophistication, as evidenced, for example, by the Statistics Center at Gotha in West Germany. North America and more recently several Asian countries—e.g., Japan, India, and Hong Kong—are receiving greater attention from population cartographers. But there are still some countries for which no official population data exist, and therefore they have not drawn the attention of mappers, except where field surveys have gathered first-hand data. Saudi Arabia, Ethiopia, other African countries, and some Latin American and Middle Eastern countries are seldom mapped because of the dearth of population data.

The cartographic communication of population data is a complex process. Figure 9-1 describes the cartographic processing system. Although highly generalized, it indicates the stages at which errors can be introduced into the system. Depending on the purpose of a thematic map—i.e., whether it focuses on population numbers only, or on specific locations of different populations—and depending too on the cartographer's methodology, the map may take various forms. In fact, no two cartographers, given the same data, the same problem, and the same instructions, are likely to produce identical maps. Because perceptual capacities of readers may also vary, in selecting a methodology the cartographer must take into account not only the nature of the data and purpose of the map, but also the sophistication of the user. Muehrche has emphasized cartography's concern with the relative effectiveness of different mapping techniques and the need to understand clearly the uses of the information being conveyed (Muehrche, 1972).

Figure 9-1. The cartographic processing system



Source: Adapted from Muehrche (1972).

Thus we see that various external influences set constraints on the mapping process and contribute to the possibility of error inherent in all cartographic techniques. With the advent of computer mapping, development of general communication theories, and im-

improvements in drafting equipment and techniques, the sources of error in conventional cartography have become more obvious, much to the concern of cartographers. Morrison (1971) has outlined potential error sources as being (1) those associated with the collection, recording, and initial manipulation of data; (2) those inherent in the mapping technique selected for use (method-produced error); (3) those arising from human or mechanical rendering of the given step-by-step procedure of a technique; and (4) those associated with the reading and the interpretation of the mapped data. Each of these is further subdivided into the two classes: mechanistic (i.e., those produced by the machinery aiding cartographers) and manual (those resulting from human intervention in the cartographic process). The possibility of error is also increased by the use of cartographic symbology for representing spatial relationships. The scaling, abstraction, interaction, and form of the symbols can distort graphic representation and therefore data communication.

The effectiveness of various point and linear symbols in representing area or volume data has been analyzed in several studies. Shortridge (1968) has criticized the dot mapping technique, citing four error sources: density of distribution, size of unit, degree of generalization, and method of dot placement. Robinson and Sale (1969), calling attention to the disadvantages of using point symbols or dots to represent population densities, asserted that it is difficult for the untrained reader to estimate relative visual densities on an internal scale; that the legend provided is usually not adequate, and should give sample densities for the reader to use as a base; and that only one relationship (e.g., ratio of population to area) is portrayed at any one time. Flannery (1971) has noted that when graduated point symbols are used, the reader perceives smaller quantitative differences than intended because of an underestimation of circle size differences.

Though isarithmic maps show gradient, direction of change, and amount of change, these are only very generally perceived by the reader. For example, two maps showing population density in India, one using the centroids of all the minor civil divisions as control points, and one using only the centroids of the States, would reveal very different patterns for the same areas because of differences in the level of generalization. The sizes and shapes of enumeration districts may affect the position of isarithms as well as the complexity of the "real" distribution itself and the "error" effects of the procedures employed in the mapping process (Hsu and Robinson, 1970).

These are the common sources of error in population mapping. Research on aesthetic aspects of symbol portrayal and the psychophysics of human perception of mapped data has also produced a rich harvest of effective cartographic tools. According to Crawford (1971) the use of uniform gray tones enhances the clarity, readability, and aesthetic quality of monochromatic maps and increases their visual effectiveness. Meihoefer (1973) found that the different sizes of circles used as point symbols are difficult to use for accurate quantitative comparisons. To overcome this difficulty he recommends the use of range-graded circles, varying in size according to an experimentally derived key, and the inclusion of a legend with as many circle size differences as are found in the map. Recently, other psychological studies have resulted in some breakthroughs on the effectiveness of map design elements (Morrison, 1971). Some specific map design elements that aid effective data communication are detailed below.

CARTOGRAMS

WHAT IS A CARTOGRAM?

For the general geographer it may be any diagram used in geography which is not a map.

For the theoretical cartographer it may be "equivalent to a form of map projection" (Tobler, 1963:61). For our purposes here it will be regarded as any "map" in which locational information has been systematically readjusted for a specific purpose. In the cartogram portrayed in Figure 9-2 the specific purpose was to represent the population sizes of the countries of the world. Relative location (i.e., Burma is east of India and south of China) and hence contiguity of areal units is maintained; but the geometry, and hence the area and the shape of the map, is distorted. The result is intriguing and perhaps confusing. Intriguing because the true shape is contorted, although this is common to all maps of our three dimensional world, and confusing because the conventional geographical background we are mentally familiar with no longer holds true. Boundaries, coastlines, rivers, and routes are all modified. Similar cartograms may be drawn at other than world scale and to represent different natural resources, demographic variables, and stages of economic development.

HOW HAVE CARTOGRAMS BEEN USED IN POPULATION GEOGRAPHY?

(a) *Cartograms for portraying population patterns*: Since Ervin Raisz's rectangular statistical cartogram of the population of the United States appeared in the 1934 *Geographical Review*, both geographers and others have used the method of areal distortion to represent various population characteristics. Raisz followed his U.S. example with a cartogram of world population in 1935. A highly contorted but less angular cartogram of the same theme accompanied Woytinsky and Woytinsky's *World Population and Production* (1953).

The technique soon became widely used, e.g., in Weigert et al.'s assessment of political power (1957), Howe's atlas of diseases (1973), Hollingsworth's map of electoral returns (1966), Hunter and Meade's models of the Chinese ethnic population in Thailand (1971), and Buchanan's "Profiles of the Third World" (1967).

(b) *Cartograms for portraying population movement*: Several broad themes can be identified in this category. There are cartographic representations of the actual movements of people, the movement routes used, the rates of movement—e.g., maps of travel time in Seattle (Bunge, 1962), and of barriers to movements (Watson, 1955). These methods of cartographic representation are common in discussions and publications on spatial patterns and processes (e.g., Abler, Adams, and Gould, 1971). An interesting but less exploited development has been the logarithmic mapping of distance, introduced by Edgar Kant to aid Hägerstrand's (1957) representation of Swedish migration. A series of logarithmic azimuthal projections centered on Aasby, Sweden, was used to portray population migration away from the town. The logarithmic transformation enlarged nearby areas whither migration, with its inherent distance decay function, was greatest, while distant areas with less migration were reduced in scale. Chapman (1976) analyzed the micro-scale mobility of individual villagers of Guadalcanal, British Solomon Islands (Figure 9-3). This study enlarges upon Hägerstrand's approach by using two-cycle log paper to emphasize local movements, especially longitudinally along a shore area backed by mountainous terrain. Chapman's primary contribution is the intriguing suggestion that such a distension of nearby areas and shrinking of the periphery mirrors the cognitive world, or mental map, of the movers. A similar logarithmic representation was used by Currey (1978) in portraying famine-induced migration from a village in Bangladesh (Figure 9-4). Currey showed not only the different distances travelled by the villagers, which ranged from neighboring villages to as far as Karachi in West Pakistan, but also the volume of out-migration to these places. These studies by Currey, Chapman, and Hägerstrand suggest the great analytical potential of population cartograms.

Figure 9-2. Cartogram of world population, 1975

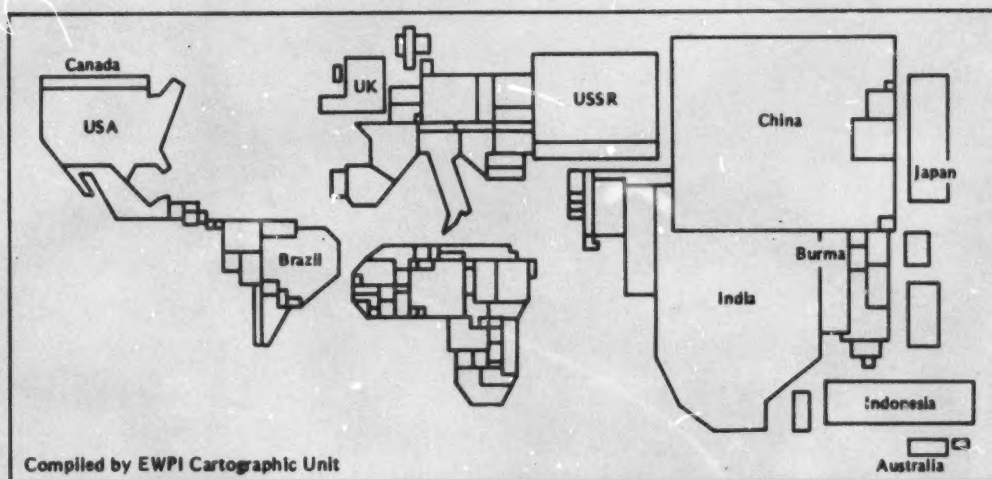


Figure 9-3. Completed moves of Marcus Pipisi, 20 November 1965–14 May 1966

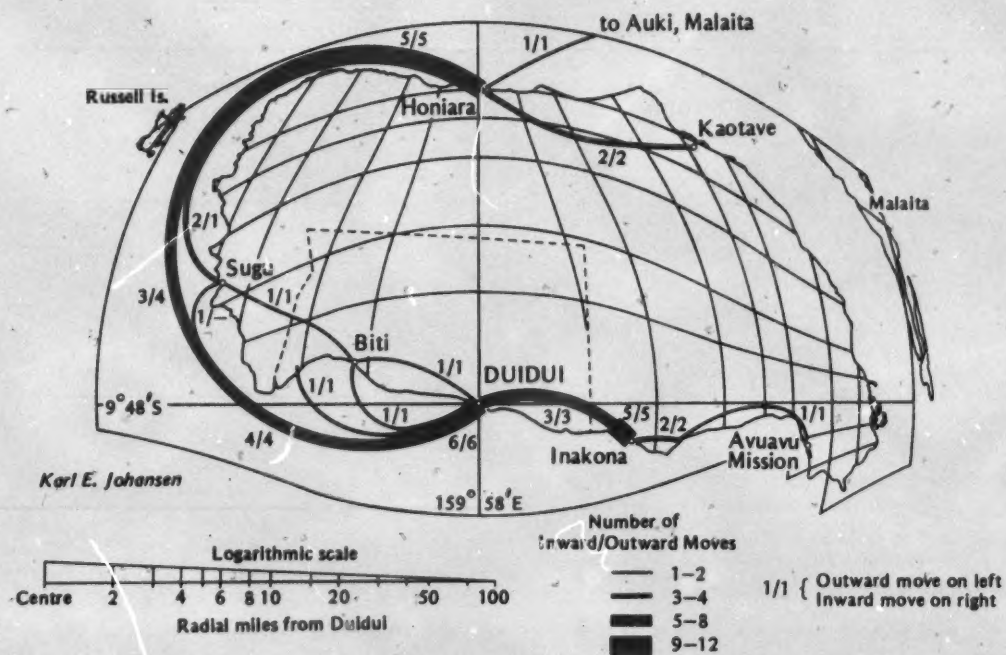
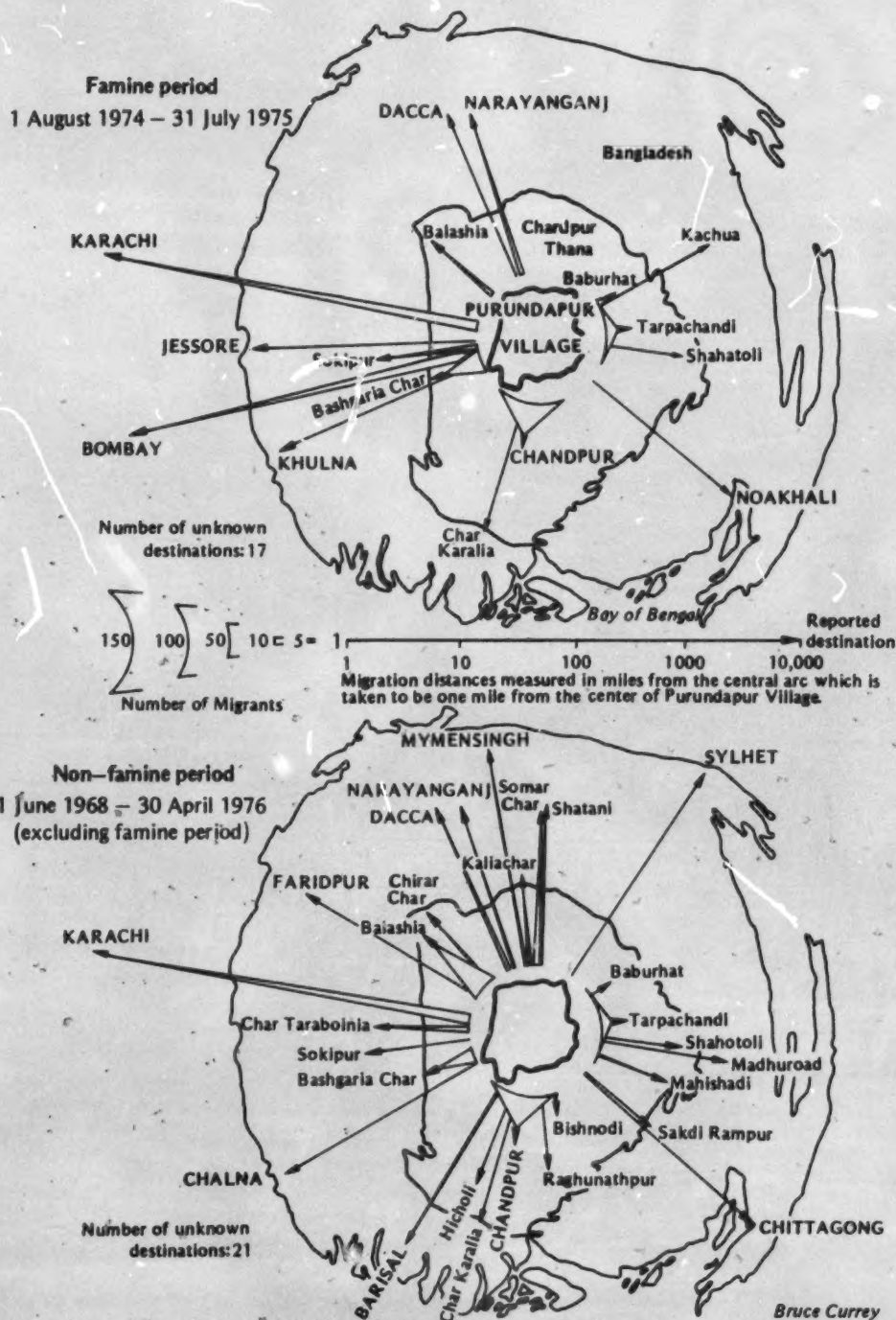


Figure 9-4. Out migration from a Bangladesh village

(Purundapur Village, Matlab Thana, population about 1000)



Note — The national and thana boundaries and the migration distances are distorted by the logarithmic transformation of distance. Data courtesy of the Cholera Research Laboratory, Dacca.

THE UTILITY OF CARTOGRAMS IN POPULATION GEOGRAPHY

The systematic distortion of geodetic space produces a striking spatial portrayal of data and provides a base map for further analysis.

When used to portray data spatially in a striking manner, a map is usually based on true geodetic distance. This does not hold true for cartograms, which, because of this departure from the normal, gain a novelty of their own. As well as being novel, such cartograms provoke interesting questions. Examination of the isodemographic (equal population) map of Canada (Figure 9-5) prompts such questions as whether the Great Lakes-St. Lawrence corridor really dominates the pattern of Canada's population and why is there so little space between Montreal and Toronto.

As base maps for further analysis, cartograms are a novel and useful way to portray what Senator Edward Kennedy has termed "people problems" of today's world, i.e., the differences between the "haves" and the "have nots." According to Hunter and Meade (1971:95), "What people are, where, and in what numbers and what conditions, is an existing reality which underlies and explains many of the world's food, power, economic and political problems." This idea has been exemplified by Buchanan (1962). Cartograms have been used by the Canadian government to analyze urban census data (Skoda and Robertson, 1972), and by epidemiologists to examine health patterns (Foster, 1966).

CONSTRUCTION OF A CARTOGRAM

Cartograms may be constructed by one of three methods: graphic, mathematical, and mechanical.

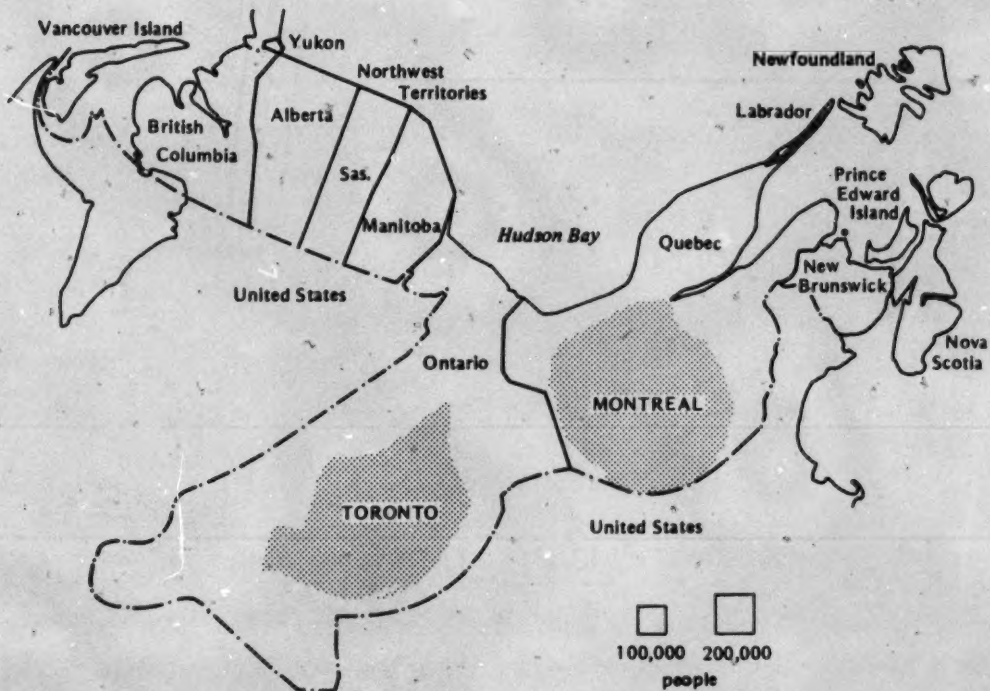
1. *Graphic*: This method, described by Raisz (1962), involves the drawing of demographic units as opposed to chorographic units; that is, the units to be represented, which may be states or districts, are enlarged or reduced according to their population size rather than their geographic area. When drawn approximately to shape, with boundary details generalized, these units can be cut out and fitted around each other to achieve a recognizable pattern of contiguity and shape.

2. *Mathematical*: The transformation of areal units into demographic units may be performed by the computer according to strict mathematical steps, for example, by expanding the radii from the centroid of the geographical unit by the proportion of population in that unit. This would produce the demographic base. Maintaining shape on a detailed and intricate outline is extremely difficult. A computer program for construction of cartograms has been developed by Tobler at the University of Michigan.

3. *Mechanical*: Instead of the repeated sketching and redrawing involved in constructing cartograms graphically, physical analogue models may be used to process the readjustment from a geographic to a demographic base. This has been done with blocks of wood to represent percentages of population (Hunter and Young, 1968). Ceramic tiles have been suggested by Hunter and Meade (1971), and ball bearings were used in the instruction booklet for the isodemographic maps of Canada (Skoda and Robertson, 1972).

As a means of understanding the function of cartograms, student participation is recommended in the mechanical construction of a cartogram, the method most stimulating for classroom use. The method is simple and the materials used in the example here

Figure 9-5. Chorographic and isodemographic maps of Canada



were selected particularly for their easy availability and low cost. The following simple steps are involved:

1. Instead of the 265,000 ball bearings and flexible metal boundaries used in the Canadian example, we need some round peas or whole mung beans, long strips of stiff but pliable paper about $\frac{1}{2}$ inch in width (the length to depend on the length of boundaries to be mapped, plus some more to stretch over the expansions), a large quantity of pins, a piece of thick cardboard or cork board, and a large sheet of hardy cartridge paper for drawing the base map.
2. The class may divide itself into groups for the different sections of the project. The first group may collect some demographic data by administrative units from the national censuses. For the example given here we use the population of Bangladesh by district.
3. Next, the base map needs to be drawn on the cartridge paper, with the boundaries and names of districts marked in pencil, as for a simple choropleth map.
4. Next, the map should be securely pinned on the cardboard or cork board. Using the $\frac{1}{2}$ -inch-wide strips of paper and the pins, "stand" the paper along all the district boundaries, buttressed with the pins as shown in Figure 9-6. Note that along common boundaries shared by two contiguous states the paper boundaries should be double. After completing each district boundary, lace an extra length of paper around the pins, in case the area is later to be expanded. Where this extra length of paper is pinned there may be three layers of paper boundary altogether.
5. Once the outline is completed, it is necessary to decide on a demographic scale, taking into consideration the extremes of highest and lowest populations. In the example here, one mung bean was made to represent 20,000 people.
6. Using either peas or beans we then figure out from the scale (1:20,000) how many of these will be needed in each district to represent the total population. Dacca District, with 5.1 million people, would require 255 mung beans.
7. Proceeding with each district, we drop the required number of beans within the walled area, then spread them out until there is a single layer of beans covering the district. Where there are more beans than will fit within the boundary, the pins are removed to expand the boundary from the center outwards, in all directions, with the relative shape of the district maintained (Figure 9-7). Where the beans are few, however, and do not cover the area of the district, the boundary is shrunk inward in all directions. It may be helpful to stick the beans with glue as you proceed, to cause less disturbance.
8. The process is repeated for all the districts or other administrative units, taking care to maintain the basic shapes. The choropleth map is then transformed into a new demographic map of population space. The cartogram with the new boundaries can be reproduced on paper placed on a pane of glass covering the model. This will yield the base map to portray other population or physical attributes such as health, income, employment, cultivable land, disaster prone areas, and potential development areas.

Choropleth maps make good base maps for research design and study, answering such questions as which areas require health facilities, which have an oversupply of health facilities relative to population, and how health facilities can be more equitably distributed.

COMPOSITE MAPS

Often population maps have a single theme. A dot map showing population distribution of the United States, when shown to an introductory student, will generally elicit little reaction. Kolars and Nystuen (1974) revealed the value of the composite map in bringing understanding to the seemingly haphazard distribution of people by compositing the environmental constraints of low temperature, aridity, and oceans. Such mapping leaves out the level of technology of the settling peoples, and the different perceptions of habitability that different cultures have for different areas. Perhaps as the spatial language of

Figure 9-6. Bangladesh: district boundaries enhanced into the third dimension by use of paper card strips and pins

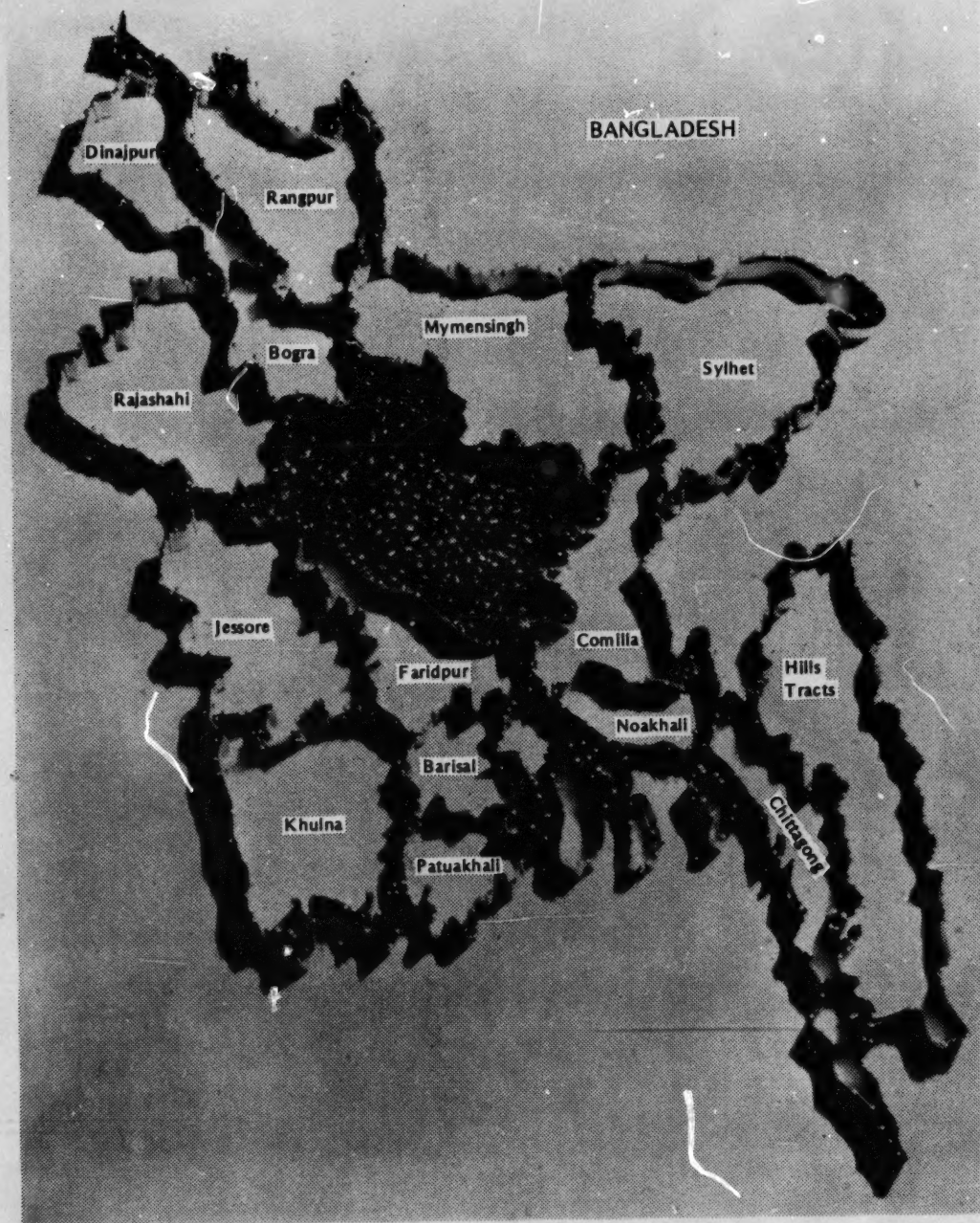
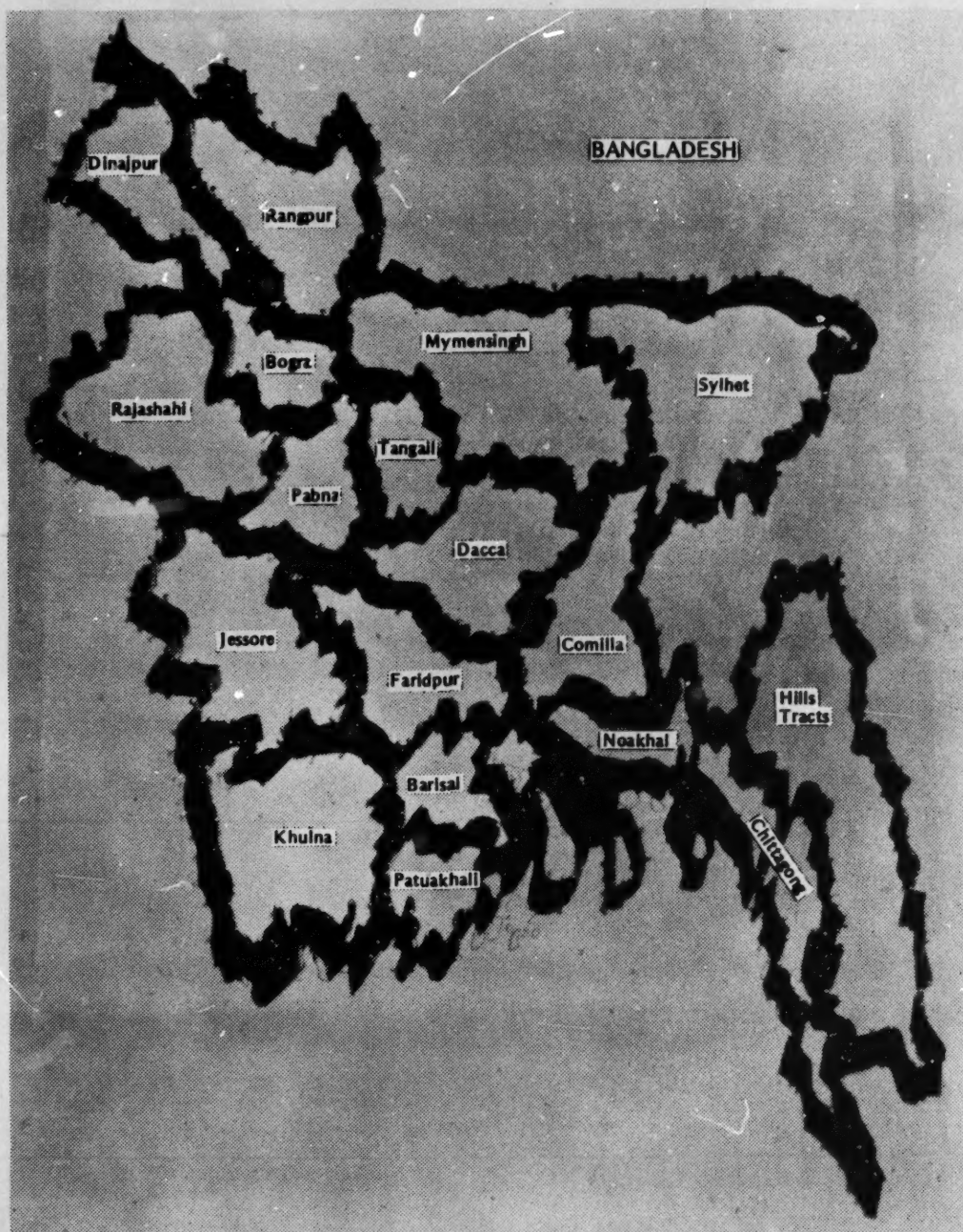


Figure 9-7. Bangladesh: district sizes adjusted according to population size



mapping matures, the understanding of such a composite map for the world distribution of population will become even more meaningful.

Reticence about using composite thematic maps may stem from a fear of suggesting causal relationships by showing areal correlations, or from a reaction to the tendency of European population geographers to overload their maps with data. The pattern that a population geographer wishes to communicate may be constructed by amalgamating symbols into a single message *on the map*. Examples of such amalgamation can be found in the bioclimatic maps of the Mediterranean published by UNESCO (1963) and the water use maps of Puget Sound and Georgia Bay by Skoda and Robertson (1973).

Figure 9-8 illustrates how the superimposition of socioeconomic variables (the human use system) and physical variables (the natural events system) enables us to identify localities prone to natural disaster in Bangladesh. If the problem is to situate a permanent store of food supplies for disaster relief where it will be most needed, we must ascertain that its location is unlikely to be destroyed by the future disaster, is not too far from the people affected by the disaster, and is not near existing relief supplies. A composite map gives an overall view of the situation and a spatial framework within which to plan. The compilation of composite maps showing actual population distribution in relation to an index of "optimal population" would reveal areas of "overpopulation" as defined for a particular environmental setting, by a particular cultural group. This could be useful if some of the definitional problems concerning the term "optimal population" were resolved, at least among those responsible for national and regional planning.

The composite map as a problem-solving tool has been underutilized in population geography. The study of population encompasses many demographic, physical, social, and economic variables that can be portrayed thematically. If the population geographer is prepared to attribute weightings to variables in a study problem, then composite thematic mapping has a role to play.

TRIFACTOR GRAPHS

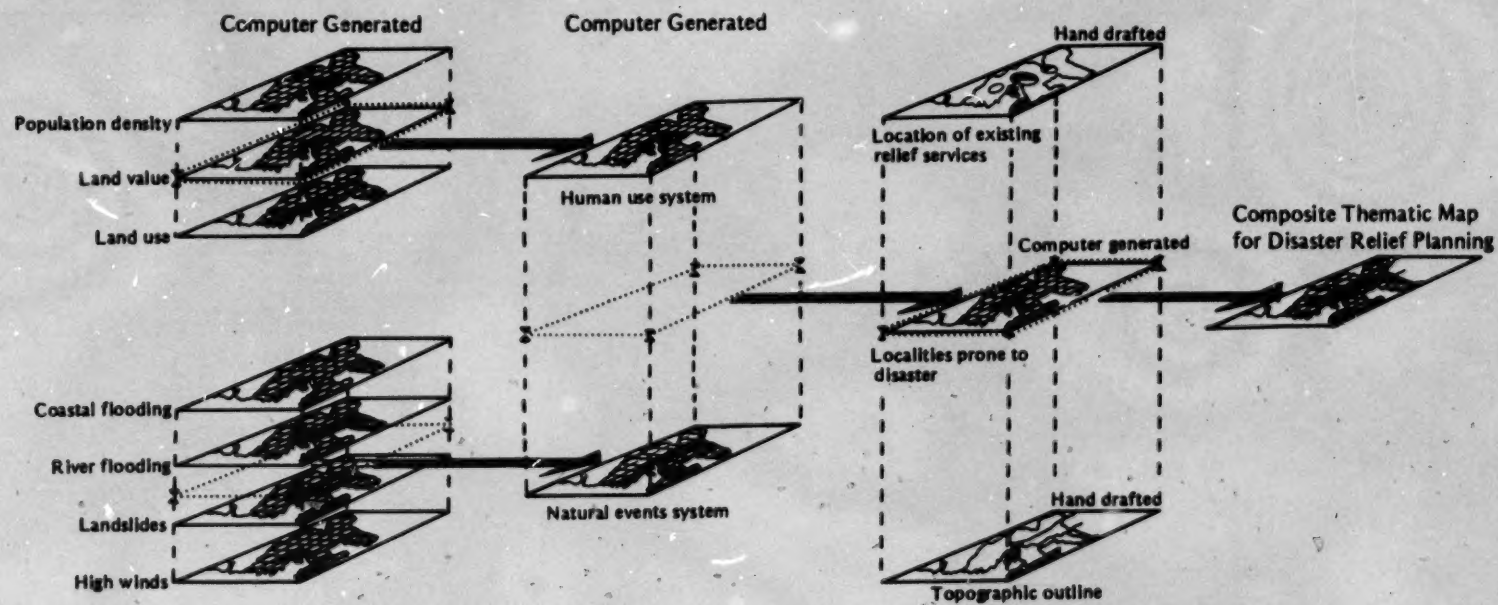
The population pyramid is the most common graph used to illustrate the age structure of a population. Unfortunately, many try to use it to show differences between two or more populations, a purpose for which it is poorly suited. The trifactor graph, on the other hand, which uses a single dot to represent each population, is admirably suited for the graphical display of changes or differences in age structure. Furthermore, its pattern can serve as the data base for a precise technique of grouping and classification.

The primary advantages of the trifactor graph over the population pyramid in the analysis of age-structure change or comparison are that a group of populations can be plotted quickly, the populations can be compared visually with ease, and they can be grouped and classified in a precise and scientific manner. Its primary disadvantage is that it can accommodate only three broad age groups for each population. But this limitation has proven to be unimportant for most purposes.

Nevertheless, the method is used infrequently, probably because interpreting a graph that has three interdependent dimensions requires more skill than interpreting a two-dimensional graph based on the Cartesian system. In the following paragraphs the mechanics of reading a trifactor graph are explained.

A trifactor graph is an equilateral triangle enclosing a grid pattern consisting of 99

Figure 9-8. Process for the construction of a composite thematic map for disaster relief planning: Bangladesh



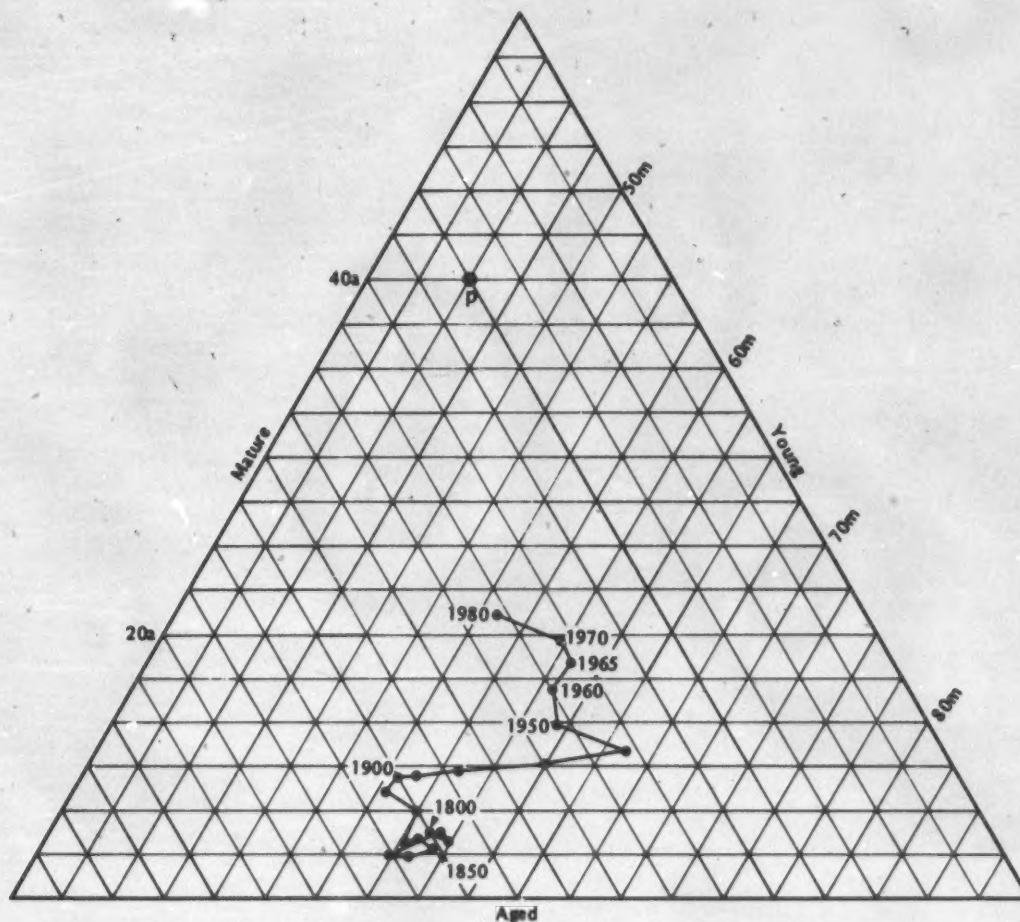
equidistant lines running parallel to each of the three sides. Percentage increments of 0, 1-99, and 100 are assigned to each side, its parallel lines, and the opposite point of the triangle, respectively. Figure 9-9, with a scale of two to one, is an expanded portion of a full graph. The labels "young," "mature," and "aged" have been selected to represent the age groups 0-14, 15-59, and 60 and over, respectively. The scales are numbered along the sides and coded with the letter *y*, *m*, or *a* to indicate the age group to which they refer. At any point where three lines (representing percentages) intersect, their values invariably sum to 100 percent. For instance, point *p* represents a population composed of 15 percent youths, 45 percent mature persons, and 40 percent aged. The 19 dots connected by dashes in the lower portion of Figure 9-9 represent real and projected changes in the age structure of the Swedish population at ten-year intervals between 1800 and 1980.

In any trifactor graph closeness of points is a measure of the similarity of the age structures being compared, whether the graph portrays different populations at a single time or the same population at different times. Thus, Sweden's early age structures, especially during 1800 to 1820, showed only minor differences. But the distance between the points representing the decades 1920, 1930, and 1940 indicates fundamental changes in the age structure of the Swedish population. In addition, the direction of change from one point to another indicates the relative size of the population in each of the three age groups. For example, between 1900 and 1940, Sweden's population was growing younger (that is, persons under age 15 constituted an increasing proportion of the population), but between 1940 and 1950 the proportion of young persons declined. Evident in Sweden's pattern of change are the period of out-migration of mature members of the population in the late 1800s, the results of the demographic transition and especially a lower birth rate during the early 1900s, and the rather extreme aging now in progress.

Figures 9-10 and 9-11 display the postwar pattern of age structure changes of the ten prefectures in Japan possessing cities of half million or more in 1970. A remarkable similarity can be seen between the changes in the more urbanized prefectures during the period 1950-70 and Sweden's pattern between 1910 and 1950. The path for Tokyo, Osaka, Kanagawa, and Aichi prefectures (possessing the four largest cities of Japan) in the 1950s are virtually straight lines running almost parallel to the base of the triangle (Figure 9-10). This pattern implies a shift from a young to a more mature population. The other prefectures, especially those containing the smaller cities of Fukuoka, Hiroshima, and Miyagi, are characterized by a different set of paths, with notably less strength, which show gains in the aged segment of the population. Two primary demographic factors that contributed to the 1950-60 patterns were a rapidly declining birth rate, especially in the more urbanized prefectures, and internal migration of mature members back to the major cities following postwar reconstruction. Both factors were considerably more in evidence in the four most urbanized prefectures, as can be seen from the strength of their paths. In fact, Miyagi and Hiroshima actually lost considerably more migrants to these larger cities than they gained from surrounding rural areas (Taeuber, 1958:125). Hokkaido's path is similar to those of the largest urban prefectures because of its large semi-frontier areas, which continued to attract migrants from the more crowded areas of Japan.

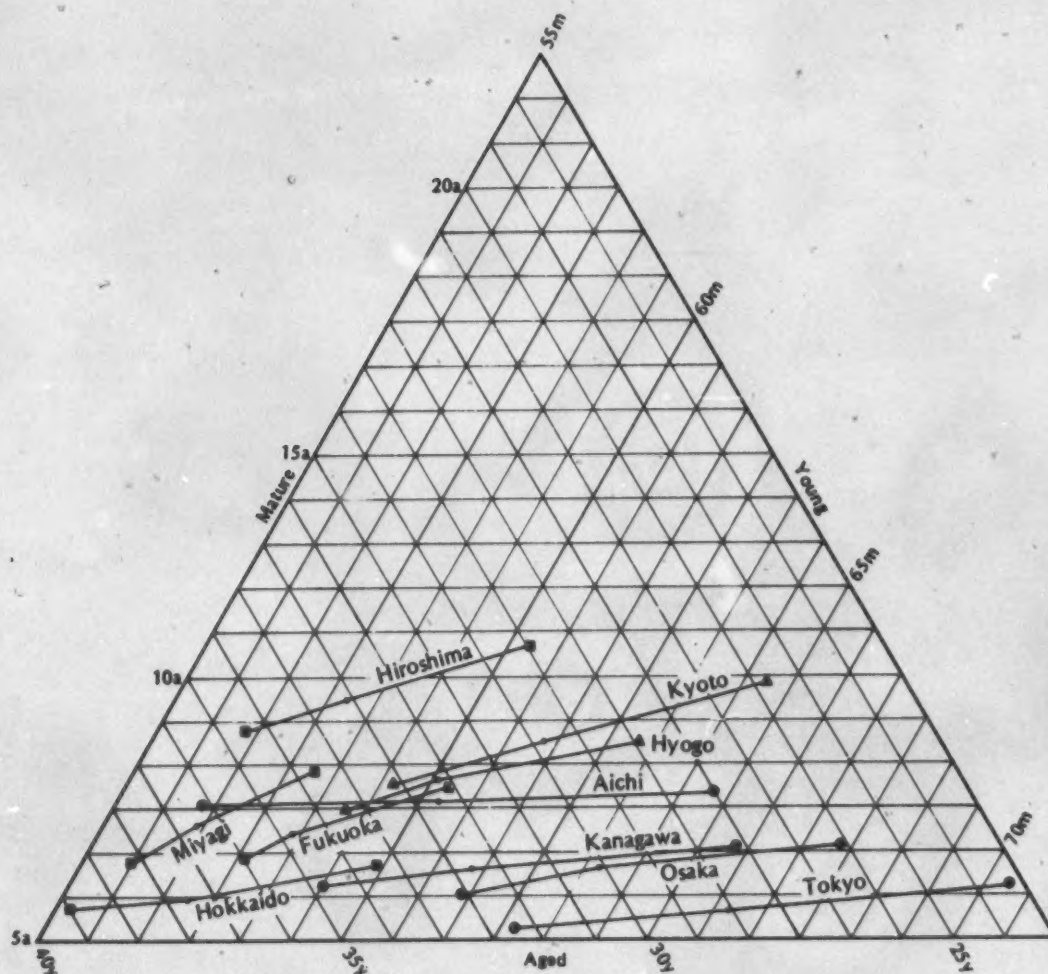
The hooked patterns of the four major urbanized prefectures during the 1960s (Figure 9-11), while appearing similar to Sweden's pattern during 1930-50, apparently resulted from different causes: a considerable increase in the metropolitan birth rate, accompanied by expansion of central city workers' residences into neighboring prefectures. Tokyo's residential hinterland expanded into Saitama and Chiba prefectures, whose 1965-70 pattern (not shown here) is a weak movement opposite in direction to that of

Figure 9-9. Changes in the age structure of the population of Sweden



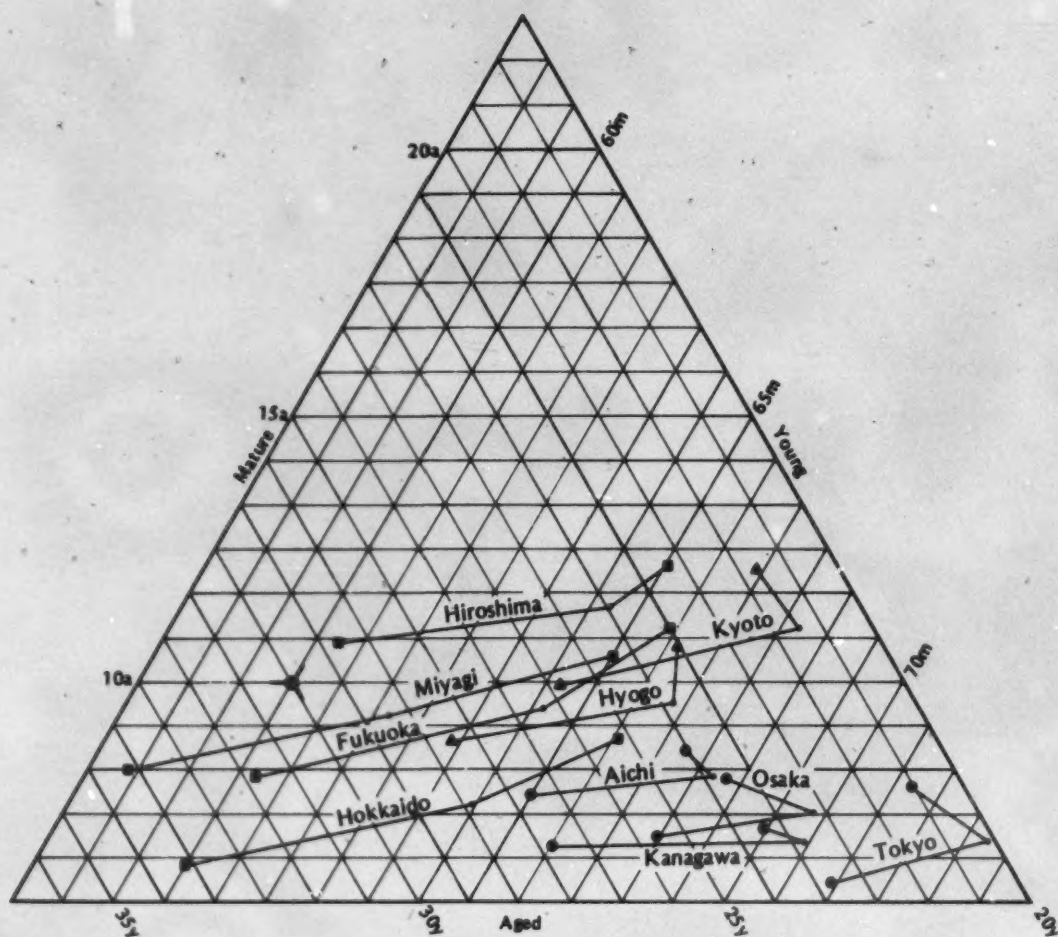
Source: Alcorn (1977).

Figure 9-10. Age structure changes in urban prefectures of Japan: 1950–60



Source: Alcorn (1977).

Figure 9-11. Age structure changes in urban prefectures of Japan: 1960–70



Source: Alcorn (1977).

the large urban prefectures, indicating a loss of aged and young members. The small size of Japanese prefectures, the high cost of housing near major cities, and Japan's well developed and efficient transportation system, all contribute to this trend. The four prefectures with the smallest major cities not only are considerably larger in area and therefore better able to absorb an expanded population, but also benefited from recent national policies to relocate industries. The 1960-70 pattern of these prefectures is further explained by the continuing effects of low birth rates, and by the maturing in the early 1960s of persons born during the postwar baby boom (this last factor being most important in those populations having the highest proportion of youths in 1960).

During the prewar years, Japanese prefectures had weak and apparently random patterns of age structure similar to Sweden's pattern during the early and mid-1800s. Japan's future pattern will likely be dominated by the increase of the aged segment. The only major observable difference between the Japanese and Swedish patterns is the lack of evidence in Japan's pattern of a period of strong international out-migration.

Throughout this discussion, Tokyo, Osaka, Kanagawa, and Aichi have been referred to as "most urbanized" or "metropolitan" prefectures, whereas Fukuoka, Hokkaido, Hiroshima, and Miyagi have been referred to as "smaller urban" prefectures. Kyoto and Hyogo prefectures, by implication, formed an intermediate category. The initial justification for such a scheme was the fact that the "most urbanized" cities had populations of over two million, while the "smaller urban" cities had populations of up to slightly more than one million. The two intermediate prefectures possessed cities of intermediate size (one to two million).

By using the graph pattern for the ten prefectures in the 1950, 1960, and 1970 decades and conducting a nearest neighbor analysis, such tentative groupings can be tested. The average linkage method (see Abler, Adams, and Gould, 1971:161-162) revealed the three-group clusters, ordered from highest to lowest proportion in the mature segment (Table 9-1). Although the clusters roughly approximate the classifications initially determined, one can go a step further and assign one point for every prefecture in the "most mature" cluster, two for those in the "moderately mature" grouping, and three for those in the "least mature" cluster. By tallying the points assigned to each prefecture the following order is determined:

- 3 - Tokyo
- 5 - Osaka
- 6 - Kanagawa
- 6 - Aichi
- 6 - Kyoto
- 6 - Hyogo
- 8 - Hokkaido
- 8 - Fukuoka
- 8 - Hiroshima
- 8 - Miyagi

The above ranking system can be used to justify the initial groupings or to determine new and more appropriate ones. A four-grouping pattern seems suggested: Tokyo, other metropolitan, intermediate urban, and small urban.

Thus, order can be determined from a static array displayed on a trifactor graph. The only skills needed for this technique are arithmetic and the ability to read a common six-

TABLE 9-1. Urban prefectures of Japan, by maturity of age structure and year

Most mature	Moderately mature	Least mature
1950		
Tokyo	Fukuoka	Hokkaido
Osaka	Hiroshima	
Kyoto	Aichi	
Kanagawa	Miyagi	
Hyogo		
1960		
Tokyo	Osaka	Hiroshima
	Kanagawa	Fukuoka
	Aichi	Hokkaido
	Kyoto	Miyagi
	Hyogo	
1970		
Tokyo	Kanagawa	Kyoto
	Osaka	Hyogo
	Aichi	Fukuoka
	Hokkaido	Hiroshima
		Miyagi

inch scale. Computer applications are unnecessary, except for the largest studies, since the technique is simple and reasonably fast.

REMOTELY SENSED IMAGES

Aerial photographs or images may be used to portray and analyze the spatial attributes of population data. Images are *iconic* models of population distributions, as opposed to maps, which are called *analogue* models (Haggett, 1972). Such images do not entail the abstraction of maps, nor the degree of data selection, generalization, and classification characterized by maps. Whereas the photographic image is overloaded with information, the map has had much of the "noise," or less relevant background information, removed. But because their images are "realistic," photographs are sometimes more easily understood by novices. With training in photo-interpretation, most persons can discern the relevant information in aerial photographs without difficulty.

Recently, because of advances in space technology, our ability to examine the world by means of photographic images has greatly increased. Large regions may be viewed at a glance with cameras or sensors placed in high-altitude aircraft and satellites. Though this leads to smaller-scale images and to decreased image resolution, the loss of detail is balanced by the increased capabilities of the sensors or camera systems.

Because photography is only one way of sensing the "real world," various remote sensors are used to supplement aerial photography. Defined as the collection of data by systems that are not in direct contact with the objects under investigation, remote sensing works by "picking up" the various wavelengths through which the earth emits its energy.

The visible spectrum that extends from 0.4 to 0.7 microns can be photographed by the camera. But microwave and infrared wavebands are also now being imaged by other sensors because they contain information not ordinarily visible but important in most scientific disciplines. Thus it is possible to sense heat such as that emitted by buildings, trees, human beings, and sidewalks by using optical scanners and film sensitive to the far infrared band of the electromagnetic spectrum.

Academic population geographers have just begun using the scales and wavelengths of remotely sensed data. But remote sensing is undoubtedly highly advanced for classified military purposes. As these sophisticated techniques and their results are released for public use, the new data available for population geography must be understood and incorporated into the discipline. One of their greatest potentials may be in census work in areas inaccessible to ground enumeration or for taking intercensal counts to estimate short-term changes.

It is relatively easy to identify such population or community attributes as urban poverty areas by analyzing house types, gardens, and block patterns (Mumbower and Donohue, 1967; Davies et al., 1973). Estimation of population size, however, must be carried out by using population surrogates. This may be better understood by examining three scales of enumeration employing remotely sensed data:

1. The sensing of individual persons can be carried out by imaging the heat of individual bodies in the infrared waveband. Bodies are normally warmer than their surroundings at night. If people are not inside air-conditioned or impenetrable buildings, a low-flying aircraft taking infrared images of a settlement in the early hours of the morning could possibly take a more accurate head count than would be possible under difficult field enumeration conditions.

2. It would be possible to detect buildings occupied by people (by sensing the "hotter" buildings). If a coefficient were computed for household size within a region, it would be possible to infer the population of a region from the house count. Eyre et al. (1970) carried out such a study in Jamaica, illustrating the possibilities of extrapolating census results from well enumerated areas into partly censused areas. They noted, however, the constraints of this method imposed by multipurpose and multistory buildings, temporary dwellings, vegetation camouflage, and variations in average household size.

3. Further along the scale from the individual to the collective enumeration unit, estimates of areas or diameters of cities can be used to estimate population size. Holz et al. (1973), working with aerial photographs of the Tennessee Valley in the United States, compared the area of urban places with their population size. Similarly, Tobler (1969) used satellite imagery to derive a mathematical relationship between urbanized area and population size in the Nile Delta.

Too often it is thought that such exercises are possible only for the fully trained researcher in possession of a large grant and a computerized digital enhancer. But they can be undertaken with a simple photographic darkroom, as described in the following experiment.

Given a January 1973 ERTS (Earth Resources and Technology Satellite) image of the Nile Delta, obtainable from the EROS Data Center in Sioux Falls, South Dakota, one can isolate the urban areas of the delta and compare them with those shown in earlier satellite imagery (Gemini series) to compute population growth between the two dates. A population geographer might be especially interested in the spatial dimensions of that growth. Comparison would reveal where growth has been the greatest.

Assuming that growth has been predominantly around the periphery of the urban areas, it will be possible by photographic subtraction to illustrate the growth areas between 1965 and 1973 thus:

1. Enhance or "pick out" the lighter gray tones of the urban areas from the ERTS image of 1973 by stopping the development of a negative on high contrast film (e.g., Kodalith 2556) as soon as the urban areas come out as black.
2. The same process is carried out for the earlier (1965) image.
3. There are now two images showing only the Nile urban areas in black at different time periods.
4. Equalize the scales of these photographs, so that one can be superimposed over the other. Growth has occurred in those areas of the 1973 image that extend beyond those of the earlier image.
5. To isolate this change, first make a negative of the enhanced image (total isolation) of the 1973 ERTS image—i.e., the product of step 1 above—by "contacting" it onto another Kodalith film. Overlay the negative of the earlier image as enhanced in step 2 above. Now the black urban areas of the earlier image overlie the white urban areas of the 1973 image. Contact this overlay onto a positive and the new growth areas will appear black.
6. The new growth areas can now be compared with the earlier satellite image.

COMPUTER MAPPING

The hand-held drafting pen transfers the human "vision" of some population data into a graphical display. The computer program, if given the format for a vision, may portray the same data, not with a pen, but with a line printer, line plotter, or cathode ray tube display unit. Like the hand-drafted maps, the computer program coordinates the production of points, lines, areas, or volumes. With three output devices and four elements, a matrix can be constructed to illustrate the library programs available to the population geographer (Table 9-2). For reference, an index of computer mapping programs appears at the end of this section.

Computer drafting has both advantages and disadvantages. The advantages are described in review articles by Hägerstrand (1967), Balchin and Coleman (1967), and Gould (1970). They include:

1. Rapid calculations prior to mapping, e.g. construction of trend surfaces (Fuller, 1966), running averages, residuals, and land composites.
2. Fast and accurate interpolation decisions for mapping—e.g., where to align a contour between three control points.
3. Choice of scale, size, and orientation once the base map has been fitted to the template of the library programs.
4. Fast drafting, especially by the cathode ray tube (instantaneous) and the line printer (about 200,000 symbols per minute).
5. Dramatic saving in effort, varying with the amount of the data to be handled. For example, a class exercise map may take longer to complete by computer than by hand, but a mapping of the 1971 Canadian census could be handled much more quickly by computer (Tomlinson, 1972).
6. Greater accuracy with the line printer, which can differentiate changes of direction down to 0.0125 mm.

The disadvantages of computerized mapping include the following: All source data must have locational coordinates—for example, geo-coding of census data to define the position

TABLE 9-2. Examples of frequently used packaged programs for specific types of output

Information	Printer	Plotter	Cathode Ray Tube
Points	CHART GEOMAP	POPULATION DISTRIBUTION DOT MAP INDMAP SIRKEL	WATER RESOURCE DATA
Lines	SECTION CONTOURING SYMAP	TOPOGRAPHIC MAP CONTOURS DISTRIBUTION MAPS PFEIL FLTODE/XSECT EZPLOT	COMPUTER AIDED MAP COMPILATION RAINBOW
Areas	PARIS VIEWIT ELECTROSTATIC CENSUS LINMAP COLMAP GRID	LAND USE MAP SOIL MAP VIEW CALFORM GIMMS	GSMAP PSEUDO COLOR ANALOG DISPLAY DIGITAL DISPLAY COLOR MAP CITY
Volume (three-dimensional)		ANALGLYPH MAP CAM PERSPECTIVES SHOCTR INCLIN YOELI SURFACE SYMVU PERSBLOCK ISOTER DESPER OBLIX	CONTINUOUS TONE IMAGERY GRAPHIC

SOURCE: Adapted from Tomlinson (1972).

of a point or points on a map. The construction of data decks for the initial map can be tedious. The core space needed in the computer may be excessive, especially for problems involving interpolation, and thus necessitate at least medium-sized computers and a substantial budget. Moreover, the line printer lacks clarity. This typewriting device, which is used for most printing of noncartographic work, initially gave computer mapping a poor image. Unfortunately, relatively few computer centers outside North America and Europe have such auxiliary hardware as line plotters or cathode ray tubes. Finally, the computer gives any map an aura of accuracy, whether accurate or not; when the verisimilitude is unwarranted, it can be misleading.

With the increasing popularity of automation in cartography, there has been a phenomenal increase in compilation speed, accuracy, and flexibility of data manipulation and display. Though computer technology can provide the information with the required ac-

curacy that each user may need, the user may not recognize the map output, for the aesthetic quality of the map suffers. The problem of positional (planimetric) accuracy is not solved either. Muehrche (1972) insists that this is not critical in thematic mapping, and that increased production speed and greater mapping flexibility are the more important characteristics. They allow a larger number of maps to be produced to serve the needs of urban-regional planners and policy makers.

With the scientific revolution in map-related disciplines and the development of information theory, the cartographic process is now frequently viewed as an "active feedback system," involving data collection, data processing, information display, and image processing. This systems approach, with its strong emphasis on the interdependence between the steps in cartographic information processing, is slowly replacing an historical tendency to consider cartography as essentially a mapping problem (Muehrche, 1972).

INDEX OF COMPUTER MAPPING PROGRAMS

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